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ABSTRACT

This individualized, self-paced correspondence course in carpentry has been adapted from military curriculum materials for use in vocational and technical education programs. This first volume of a two-volume set is designed to present the theory portion of carpentry and basic skills. The Carpentry I course contains four lessons. Lesson 1, Job Safety, discusses building maintenance safety and construction site safety. Lesson 2, Working Drawings and Building Materials, covers plot, foundation, framing, and floor plans; elevations; sections and details; symbols and terms; common abbreviations; specification; sketching; billing of materials; and lumber. In lesson 3, handtools, the care and use of boring tools, cutting tools, and miscellaneous tools such as fastening and measuring tools are discussed. The final lesson, Woodworking Power Machinery, Ladders, and Scaffolds, covers saws, sanders, shaping machines, drills, portable power tools, ladders, and scaffolds. Each lesson contains an objective with reading assignments, exercises, and answers to the exercises. The answers are keyed to the text for student self-study and evaluation. A course examination, without answers, is provided. (This course is recommended for use in a shop or on-the-job learning situation.) (KC)

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MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

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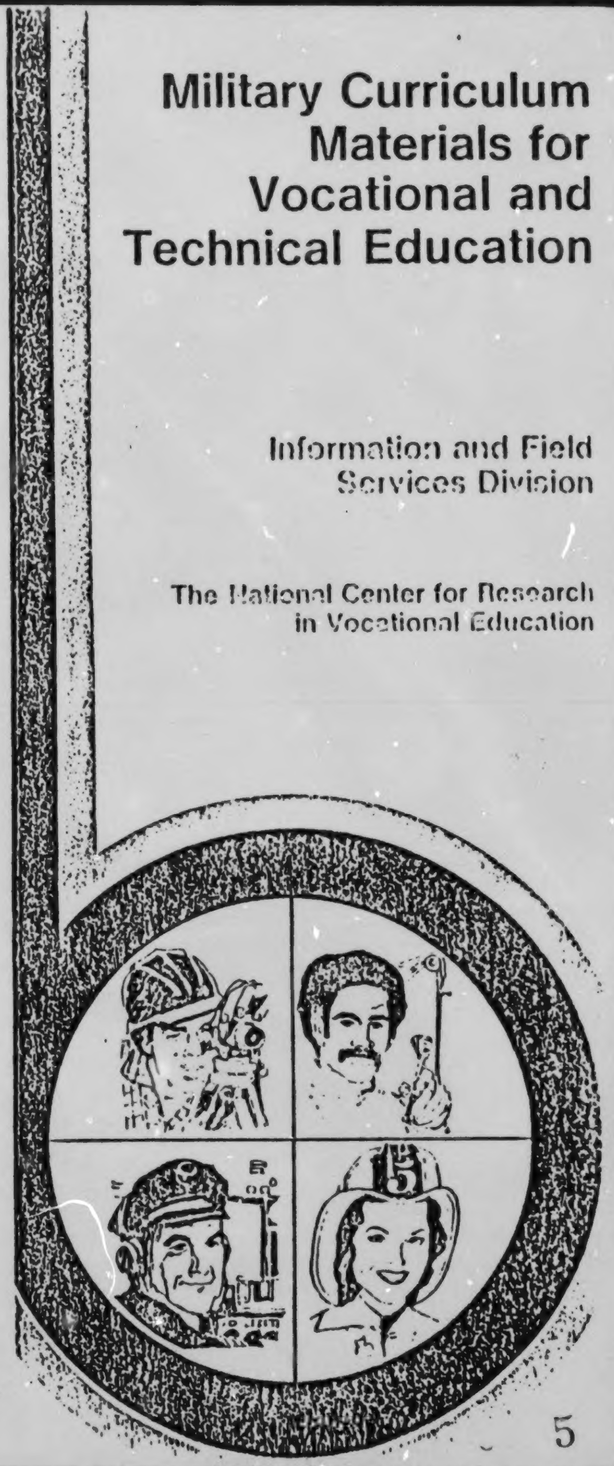

Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

- Agriculture
- Aviation
- Building & Construction Trades
- Clerical Occupations
- Communications
- Drafting
- Electronics
- Engine Mechanics
- Food Service
- Health
- Heating & Air Conditioning
- Machine Shop
- Management & Supervision
- Meteorology & Navigation
- Photography
- Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

MIDWEST
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Honolulu, HI 96822
808/948-7834

CARPENTRY I & II

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Carpentry I (Tools & Equipment) -
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Carpentry II (Frame Structures)
Memorandum 532-0 - text material — Page 134

CARPENTRY I & II

Correspondence Course

Developed by:

United States Army

Development and Review Dates

Unknown

Occupational Area:

Building and Construction

Cost:

$5.00

Print Pages:

239

Availability:

Military Curriculum Project, The Center for Vocational Education, 1960 Kenny Rd., Columbus, OH 43210

Suggested Background:

None

Target Audiences:

Grades 10-adult

Organization of Materials:

Text; student workbook with assignments, objectives, exercises, solutions and discussion; course examination

Type of Instruction:

Individualized, self-paced

Type of Materials:			**No. of Pages:**	**Average Completion Time:**
Carpentry I	–	*Tools and Equipment*	76	Flexible
		Student Workbook and Examination	25	
Carpentry II	–	*Frame Construction*	103	Flexible
		Student Workbook and Examination	27	

Supplementary Materials Required:

None

Expires July 1, 1978

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Course Description

This two-volume course is designed to present the theory portion of carpentry. It covers tools, equipment and basic skills.

Carpentry I contains four lessons with objectives, readings, review exercises, answers to the exercises and discussion of the answers.

Lesson 1 – *Job Safety* discusses building maintenance safety and construction site safety.

Lesson 2 – *Working Drawings and Building Materials* covers plot, foundation, framing, and floor plans; elevations; sections and details; symbols and terms; common abbreviations; specifications; sketching; billing of materials; and lumber.

Lesson 3 – *Handtools* discusses the care and use of boring tools, cutting tools, and miscellaneous tools such as fastening and measuring tools.

Lesson 4 – *Woodworking Power Machinery, Ladders, and Scaffolds* covers sawing machines, sanding machines, shaping machines, drilling machines, portable power tools, ladders, and scaffolds.

Carpentry II contains four lessons with objectives, readings, review exercises, answers to the exercises and discussion of the answers.

Lesson 1 – *Building Layout and Floor Framing* discusses how to locate and layout a building site and the methods and materials to be used in construction foundations.

Lesson 2 – *Exterior Framing* explains how to make a building layout and do floor framing, and the purpose and use of sills, girders, joints, and bridging.

Lesson 3 – *Roof Framing and Materials* covers the methods and procedures for constructing roof frames and coverings including the selection of materials and the use of tools.

Lesson 4 – *Interior Framing* explains the methods for installing and maintaining interior walls and ceilings, doors and window trims, and floors and stairways.

Each lesson contains an objective with reading assignments, exercises and the answers to the exercises. The answers are keyed to the text for student self-study and evaluation. A course examination is available for each section, but no answers are given. This course would best be used in a shop or on-the-job learning situation.

ENGINEER
SUBCOURSE 531-0

CARPENTRY I

(TOOLS AND EQUIPMENT)

CORRESPONDENCE COURSE
U.S. ARMY ENGINEER SCHOOL

FORT BELVOIR, VIRGINIA

3-8

MOS: 51B20

EDITION 0 (NRI 011)

INTRODUCTION

This is one of a series of subcourses intended to assist enlisted personnel of the Army to improve their proficiency in engineer MOS job requirements.

This subcourse, together with two others entitled "Carpentry II (Frame Construction)" and "Carpentry III (Specialized Carpentry)" can help you qualify in the MOS 51B career field. Part I begins with a discussion of safety measures and then takes you through the use of drawings, prints, handtools, power machinery and scaffolds.

This subcourse is based on material in the accompanying memorandum and consists of four lessons and an examination as follows:

Lesson 1. Job Safety
2. Working Drawings and Building Materials
3. Handtools
4. Woodworking Power Machinery, Ladders and Scaffolds

Examination

Fifteen credit hours are allowed for this subcourse. You will not be limited as to the number of hours you spend on the subcourse, any lesson, or the examination.

Text furnished: Memorandum, (Volume I), Engineer Subcourse 531.

As you complete the exercises, check your answers with the solutions provided in this subcourse packet.

When you have completed all lessons to your satisfaction, complete the examination and forward the examination answer card to the USAES for grading. The grade you receive on the examination is your grade for the subcourse.

LESSON 1

JOB SAFETY

CREDIT HOURS ---------------------- 3

TEXT ASSIGNMENT ------------------ Study chapter 1 in Memorandum (Volume I).

LESSON OBJECTIVE ------------------ To teach you basic rules of safety and their application in carpentry work.

EXERCISES

Requirement: Solve the following multiple-choice exercises.

1. A "hard" hat can provide its margin of safety only when it is

a. worn to protect against falling objects

b. adjusted to provide a suitable cushioning effect

c. worn while on a multiple-story construction job

d. issued in a size to fit the wearer

2. The preferred slope for a stairway is

a. 30° to 35° from the vertical

b. 30° to 35° from the horizontal

c. 20° to 50° from the vertical

d. 20° to 50° from the horizontal

3. Objects 25 pounds or heavier should be lifted by

a. bending the waist and using the arms

b. one person only to insure equal movement

c. a hoist

d. using the legs

4. What result is likely to occur if water falls into a kettle of boiling tar?

a. may dilute the kerosene that is feeding the boiler

b. could cool the tar and make it unusable

c. might extinguish the tar-kettle fire

d. could cause the hot tar to boil over, which might start a fire

5. Workmen transported on an open-bed truck should be

a. seated on top of the load to provide weight

b. alert to watch for approaching vehicles

c. seated in front of the truck bed, facing the rear

d. seated, with feet resting on the tailgate

6. The construction work that requires the workmen to wear goggles, rubber gloves, an apron and boots, is

a. cement mixing

b. sand blasting

c. roof tarring

d. removing mortar stains with acid-water solution

7. Which one of the following causes kickback on powered rip saws?

a. sawing knotted lumber

b. fence out of line

c. sawing straight-grained lumber

d. use of a spreader

8. What would you use to clean sawdust and slivers from a power saw?

a. file c. brush

b. rags d. compressed air

9. How can you prevent injury when using a power saw to rip short or narrow pieces of work?

a. use pusher stick

b. keep stock against the gauge

c. keep guards in place

d. keep stock against the fence

10. How many pounds of live load per square foot should all stairs and landings be able to sustain?

a. 100 c. 135

b. 120 d. 150

11. A workman should wear a respirator when

a. boiling tar c. mixing mortar

b. laying brick d. shingling

12. How near a boiling tar kettle would you place a fire extinguisher in feet?

a. 25 c. 40

b. 30 d. 50

13. What is the least tread width in inches recommended for a stairway?

a. 7 c. 9½

b. 8 d. 11

14. How many pounds of thrust should the top rail of all railings be able to withstand?

a. 350 c. 250

b. 300 d. 200

15. You should not construct a stairway that is

a. less than 20° nor more than 50° from the horizontal

b. less than 30° nor more than 40° from the horizontal

c. less than 30° nor more than 50° from the horizontal

d. less than 20° nor more than 60° from the horizontal

LESSON 2

WORKING DRAWINGS AND BUILDING MATERIALS

CREDIT HOURS ------------------------3

TEXT ASSIGNMENT ------------------Study chapter 2 in Memorandum (Volume I).

LESSON OBJECTIVE ------------------To teach you how to use drawings and prints and to solve problems pertaining to building construction.

EXERCISES

Requirement: Solve the following multiple-choice exercises.

1. General drawings consist of

a. plans and elevations
b. plans and sectional views
c. plan views and vertical dimensions
d. vertical dimensions and sectional views

2. A window in which the sash opens upon hinges is called

a. casement
b. casing
c. jamb
d. sash

3. The plan that denotes the location of doors and windows is the

a. floor plan
b. plot plan
c. wall plan
d. framing plan

4. You are given the job of hanging a door so that the hinge leaves will be hidden. What type hinges do you choose?

a. full mortise
b. half surface
c. full surface
d. special hinges

5. The framing plan that specifics the size and spacing of joists and girders is the

a. detailed framing
b. floor framing
c. roof framing
d. wall framing

6. Which of the following views are usually developed in right-angle projection?

a. plan
b. interior detail
c. sectional
d. exterior detail

7. Dimension lines are light lines that show the distance between two points and are drawn between

a. extension lines or hidden lines
b. working lines or extension lines
c. extension lines or center lines
d. working lines or hidden lines

8. Which of the following is used with a padlock to form a locking device?

a. a hasp lock

b. a mortise lock

c. a hinge hasp

d. a special hinge

9. The stock size of a board is 1" x 8". Which one of the following lists its correct actual use size?

a. 15/16" x 7 15/16"

b. 13/16" x 7 13/16"

c. 7/8" x 7 7/8"

d. 3/4" x 7 1/2"

10. Which of the following screws are best suited to fasten hinges to wood?

a. flat head c. round head

b. oval head d. phillips

11. You have 8 pieces of 2" x 6" x 12' material for floor joists. How many board feet of lumber do you have?

a. 106 c. 96

b. 98 d. 86

12. Quarter-sawed lumber

a. has less waste

b. is produced by a faster process

c. has less shrinkage and swelling

d. shows more figuration from annual rings

13. An outline of a part of a construction drawing which is invisible in a particular view is known as

a. a dimension line

b. a hidden line

c. a center line

d. an extension line

14. When lumber is seasoned, the loss of moisture causes a change in the lumber. What is this change?

a. lumber is harder and lighter

b. lumber is harder and smoother

c. lumber is shrunken and heavier

d. lumber is stiffer and heavier

15. If 100 centimeters equal 1 meter or 39.37 inches how many centimeters are there in 39.37 feet?

a. 1200 c. 120

b. 1000 d. 100

16. The plan that is drawn to scale from sketches and notes based on a survey of an area is a

a. foundation plan

b. site plan

c. floor-framing plan

d. floor plan

17. Door bolts are used for the same purpose as elbow catches. Where are they installed when used as a catch for a double door of a book case?

a. top and bottom of right-hand door

b. top and bottom of left-hand door

c. top or bottom of right-hand door

d. top or bottom of left-hand door

18. You have been told to remember two numbers (.3048 and 3.281) for converting the linear system to the metric system and vice versa. With this in mind, how many meters are there in 15 feet?

a. 49.215 c. 4.9215

b. 45.720 d. 4.5720

19. Why would you use scaffold nails to build a concrete form?

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a. to prevent splitting of the wood

b. to permit deep penetration in the form

c. easier to extract the nails

d. they have larger diameters than common nails

20. What type of molding used on interior walls is usually placed 48 inches above the floor?

a. picture mold

c. shelf cleat

b. panel mold

d. chair rail

2—3

LESSON 3

HAND TOOLS

CREDIT HOURS ________________________ 4
TEXT ASSIGNMENT ___________________ Study chapter 3 in Memorandum (Volume I).
LESSON OBJECTIVE ___________________ To teach you the various uses of hand tools, their care, and the identification of the different types of tools.

EXERCISES

Requirement. Solve the following multiple-choice exercises.

1. To drill a ½-inch hole, you should select an auger bit marked number

a. 2
b. 4
c. 6
d. 8

2. Which of the following has more than one cutting edge?

a. hand axe
b. half hatchet
c. broad hatchet
d. shingling hatchet

3. What type of file is used to sharpen the spur and nib of an auger bit?

a. three-cornered
b. half round
c. flat
d. round

4. A block plane is designed primarily for planing

a. end grain
b. minor depressions
c. when other planes are too large
d. when the thickness of the cut must be controlled

5. Twist drills are used to bore holes for which of the following fasteners?

a. bolts
b. spikes
c. drift pins
d. timber connector

6. If you were setting a saw with a sawset, you would

a. use a three-cornered file
b. bend every other tooth in the same direction
c. bend every tooth at 45° angle to the saw blade
d. bend every other tooth halfway from the point

7. If you found it necessary to apply unusual power on a chisel, you would select a

a. mill chisel
b. slick chisel
c. heavy butt chisel
d. mortising chisel

8. To restore the circular form of a grindstone, it is best to use a

a. heavy file

b. heavy piece of steel

c. another grindstone

d. emery wheel dresser

9. To sharpen a chisel correctly, how would you grind the bevel?

a. slightly bowed

b. slightly concave

c. straight

d. slightly convex

10. A combination square will not do the work of which one of the following measuring and leveling tools?

a. level c. rule

b. dividers d. depth gauge

11. On which one of the following would you use a slipstone to sharpen the blade?

a. plane c. chisel

b. spoke shave d. drawknife

12. Which of the following planes gives the straightest cut?

a. trying plane

b. jointer plane

c. jack plane

d. smoothing plane

13. In setting the teeth of a hand saw, the amount of set that you would use is

a. 1/8 inch

b. thickness of the saw blade

c. 1/16 inch

d. 1/2 thickness of the saw blade

14. Which one of the following is not a leveling tool?

a. chalk line c. plumb bob

b. try square d. common level

15. Which of the following would you use on a finished board in order to prevent the appearance of "cat paws" on the board?

a. nail set to set the nails

b. nail punch

c. leather mallet

d. lightweight hammer

16. Which general tool is classified as a smooth facing tool?

a. hatchet c. plane

b. drawknife d. axe

17. Which plane has a bit that is slightly curved?

a. jointer c. jack

b. smoothing d. block

18. Which of the following is a rough facing tool?

a. jack plane c. drawknife

b. spoke shave d. half hatchet

19. When is it necessary to grind a chisel?

a. before it is nicked

b. after it is honed

c. when it is badly nicked

d. when the edge needs rounding

20. Which of the following is a driving tool?

a. screwdriver

b. claw hammer

c. openend wrench

d. socket wrench

LESSON 4

WOODWORKING POWER MACHINERY, LADDERS AND SCAFFOLDS

CREDIT HOURS ------------------------3

TEXT ASSIGNMENT -------------------Study chapters 4 and 5 in Memorandum (Volume I).

LESSON OBJECTIVE -------------------To teach you the safe and correct operation of woodworking power machinery and the safe erection and use of ladders and scaffolds.

EXERCISES

1. With what woodworking machine is a steel guidepost used for starting the cut and then withdrawn?

a. lathe
c. jointer
b. table saw
d. shaper

2. What parts of a wood lathe are used during faceplate turning?

a. live center and metal disk
b. headstock and metal disk
c. tool rest and live center
d. faceplate and live center

3. Which of the following machines would you use to surface, rabbet, bevel, or edge a piece of work?

a. planer
b. jointer
c. circular saw
d. disk-spindle sander

4. If you compared the solid headcutter on a spindle wood shaper with the flat knife cutter, you would find that the solid headcutter has

a. one less cutter
b. two more cutters
c. one more cutter
d. same number of cutters

5. Which type of sander sometimes has a two-way action?

a. belt
c. disk
b. drum
d. spindle

6. When would you use a push board?

a. re-sawing stock on a band saw
b. crosscutting on an overarm saw
c. planing wide boards on a jointer
d. ripping wide boards on a table saw

7. Which one of the following machines has rear and front tables, fence, guard, and cutting head as its main parts?

a. shaper
c. table saw
b. planer
d. jointer

8. You are using a skew chisel in connection with a lathe. How far from the stock do you place the tool to rest?

a. ½ inch
b. ¼ inch
c. ⅜ inch
d. ⅛ inch

9. Which of the following would you use to regulate the length of a mortise?

a. cutting chuck
b. special guards
c. foot treadle
d. spacing gauge

10. You are turning a project on the lathe and you want to make a concave recessed cut. Which of the following tools do you use?

a. gauge
b. skew chisel
c. round point chisel
d. square point chisel

11. You wish to complete a book case by giving it a high gloss finish. Which of the following sanders would you use, with a felt pad, for this purpose?

a. spindle
b. drum
c. oscillating
d. disk

12. While turning around the two large wheels, band saw blades are kept in place primarily by the

a. tension applied to the blades
b. saw guides
c. friction applied to the blades by the friction wheels
d. two set guides and the friction wheels

13. How are the components of a dado head usually arranged?

a. various size chippers between two blades
b. one blade and two chippers
c. a solid head and two blades
d. two blades and various size collars

14. What are toe boards constructed of and where are they placed on a swing stage scaffold?

a. 2″ x 4″ material and run the length of the platform
b. 2″ x 10″ planks and run the length of the platform
c. 1″ x 4″ material and run the length of the platform
d. 1″ x 8″ material and run across the platform

15. You are constructing a double upright scaffold. What is the normal spacing of uprights in feet?

a. 6 to 8
b. 7 to 10
c. 8 to 12
d. 9 to 14

16. What is the maximum number of feet to which a ladder can be extended for safe use?

a. 70
b. 60
c. 50
d. 40

17. The maximum height in feet for a step ladder when used on a job is

a. 12
b. 16
c. 20
d. 24

18. Which of the following planks would you be likely to use to form the platform of a double upright scaffold?

a. six 2″ x 10″
b. four 2″ x 8″
c. five 2″ x 8″
d. five 2″ x 10″

19. What is the maximum amount of construction material that you would store on a scaffold?

a. 6-hour supply

b. 4-hour supply

c. 2-day supply

d. 1-day supply

20. How high is the guardrail on a swing stage scaffold?

a. 40 inches

b. 48 inches

c. 30 inches

d. 36 inches

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CORRESPONDENCE COURSE OF U. S. ARMY ENGINEER SCHOOL

SUBCOURSE 531-0 .... Carpentry I (Tools and Equipment).
LESSON 1 .... Job Safety.

SOLUTIONS

Exercises 1 thru 11 have a weight of 8 each; exercises 12 thru 15 have a weight of 3 each. References are to Memorandum (Volume I).

1. *b* (par 3-47)
2. *b* (par 3-10)
3. *d* (par 3-34)
4. *d* (par 3-50)
5. *c* (par 3-37)
6. *d* (par 3-56)
7. *b* (par 3-26)
8. *c* (par 3-21)
9. *a* (par 3-21)
10. *a* (par 3-10)
11. *c* (par 3-54)
12. *d* (par 3-50)
13. *c* (par 3-10)
14. *d* (par 3-12)
15. a (par 3-10)

For further explanation see Discussion.

All concerned will be careful that neither this solution nor information concerning the same comes into the possession of students or prospective students who have not completed the work to which it pertains.

DISCUSSION

Exercise:

1. The hard hat should be adjusted by the inside cradles or hammocks in order to provide a safe cushioning effect (b).

2. You should not construct a stairway less than 20° nor more than 50° from the horizontal, but the preferred slope is between 30° and 35° from the horizontal (b).

3. Lifting heavy objects with the back can produce a back injury. Lifting is done with the legs (d).

4. Water or sometimes just moisture or dew on the tar can cause the tar to boil over onto the kettle fire box (d).

5. The best place for the workmen to sit is in the front of the truck bed, with their backs to the cab. This will prevent them from being thrown forward if the truck stops quickly (c).

6. A method to remove mortar stains from brick is the use of muriatic acid-water solution. This method requires the wearing of goggles, rubber gloves, apron, and boots for adequate protection from this acid (d).

7. Kickbacks on rip saws can result from several causes, usually improper fence alinement (b).

8. Sawdust and slivers should be cleaned from a power saw with a brush. Never clean it with your hands, a rag, or compressed air (c).

9. The use of a pusher stick permits the completion of the cut and keeps the hands away from the blade (a).

10. You should insure that all stairs, landings, and platforms are of sufficient strength to sustain a live load of not less than 100 pounds per square foot (a).

11. In mixing mortar, the workman must wear a respirator to keep him from inhaling the dusty cement. Cement is so fine that it will pass through a sieve having 40,000 openings per square inch (c).

12. The tar in the kettle is heated to more than 200°F, and the extinguisher is placed approximately 50 feet from the kettle for its safety and for quick use by the workman if the kettle catches fire (d).

13. A tread width of not less than 9½" and a nonslip nosing of 1 inch are recommended (c).

14. Side and center railings should be strong enough to withstand a thrust of 200 pounds at any point along the top rails (d).

15. You should not construct a stairway less than 20° nor more than 50° from the horizontal. Where the slope is less than 20°, you should install a ramp instead of stairs (a).

CORRESPONDENCE COURSE OF U. S. ARMY ENGINEER SCHOOL

SUBCOURSE 531-0 .... Carpentry I (Tools and Equipment).
LESSON 2 .... Working Drawings and Building Materials.

SOLUTIONS

Each exercise has a weight of 5. References are to Memorandum (Volume I).

1. *a* (par 5-2)
2. *a* (par 5-28)
3. *a* (par 5-10)
4. *a* (par 6-39)
5. *b* (par 5-7)
6. *d* (par 5-15)
7. *b* (par 5-26)
8. *c* (par 6-44)
9. *d* (par 7-22)
10. *b* (par 6-29)
11. *c* (par 6-9)
12. *c* (par 7-29)
13. *b* (par 5-23)
14. *a* (par 7-8)
15. *a* (Table 2, page 39)
16. *b* (par 5-5)
17. *d* (par 6-56)
18. *d* (par 7-23)
19. *c* (par 6-22)
20. *d* (par 7-33)

For further explanation see Discussion.

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DISCUSSION

Exercise:

1. General drawings show plans and elevations (a).

2. A window in which the sash opens upon the hinges is a casement window (a).

3. The remaining plans show site boundaries and the location of structural members. The floor plan shows size and location of wall openings (a).

4. The leaves of a full mortise hinge are completely hidden (a).

5. Only in the floor-framing plan are the sizes and spacing of joists and girders shown (b).

6. Exterior detail views are usually developed in right angle projection (d).

7. Dimension lines are light lines drawn between working lines or extension lines (b).

8. A hinge hasp is used with a padlock as a locking device (c).

9. Answer is derived from the table in par 7-22, ¾" x 7½" (d).

10. Flat head screws are used where the head will not show; the oval head scriew is used to fasten hinges to wood (b).

11. The formula to apply is in par 6-9—12' x ½' x 2" = 12' x 8 boards = 96 board feet (c).

12. Quarter-sawed lumber shrinks and swells less than plain-sawed lumber (c). The other choices are descriptive of other kinds of sawed lumber.

13. Dimension lines are used to show the size of any structural part; the center line indicates the center of an object; the extension lines extend working lines. An outline of a part which is invisible in a particular view is known as a hidden line (b).

14. Lumber can be partly affected as shown in all choices, but the loss of moisture makes wood harder, stiffer, and lighter in weight (a).

15. From table 2, read left to right 39 feet = 11.887 meters
.37 feet = .113 meters
Total 12.000 meters × 100 = 1200 cm

16. The foundation plan is the starting point in the actual construction; the floor framing plan specifies the size and spacing of joists girders, and columns; the floor plan is a cross-sectional view of the building; the site plan is drawn to scale from sketches and notes based on a survey of an area (b).

17. Door bolts are installed at either the top or bottom of the left-hand door (d).

18. .3048 × 15 feet = 4.5720 meters (d).

19. Box nails are used in box construction when there is possibility of splitting the wood with a common nail. Scaffold nails are used whenever the construction is temporary; they have a double head to make extraction easier (c).

20. The picture mold is placed flush with the ceiling, the panel mold divides wall spaces into panels; cleats support shelves in closets; the chair rail is usually placed 48 inches from the floor (d).

CORRESPONDENCE COURSE OF U. S. ARMY ENGINEER SCHOOL

SUBCOURSE 531-0 .... Carpentry I (Tools and Equipment).
LESSON 3 .... Hand Tools.

SOLUTIONS

Each exercise has a weight of 5. References are to Memorandum (Volume I).

1. *d* (par 8-2)
2. *d* (par 9-40)
3. *c* (par 8-5)
4. *a* (par 9-33)
5. *a* (par 8-6)
6. *d* (par 9-12)
7. *b* (par 9-23)
8. *d* (par 10-28)
9. *c* (par 9-26)
10. *b* (par 10-26)
11. *b* (par 9-36)
12. *b* (pars 9-32 and 9-34)
13. *d* (par 9-12)
14. *b* (par 10-15)
15. *a* (par 10-4)
16. *c* (par 9-29)
17. *c* (par 9-34)
18. *d* (par 9-39)
19. *c* (par 9-26)
20. *b* (par 10-3)

For further explanation see Discussion.

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DISCUSSION

Exercise:

1. Bit sizes are available in sixteenth of an inch from ¼" to 1", so a ½" bit is 8/16" or number 8 (d).

2. The shingling hatchet has two cutting edges (d). The hatchet blade is sharpened on the chopping edge for splitting shingles, and along the back edge for cutting felt or shaving shingles.

3. Only the flat file permits filing the spur so that the original bevel is retained (c).

4. The block plane can be used easily with one hand. It is used for planing end grain or across the grain (a).

5. Twist drills are often used to drill holes in wood or metal in which some type of wood facing will be bolted (a).

6. When using a saw set, bend every other tooth (halfway from the point) (d).

7. Any chisel having a blade wider than 2 inches is called a slick chisel. This kind is used when unusual power is needed (b).

8. The other choices are not suitable for restoring the grindstone surface. A stone dressing tool (emery wheel dresser) should be used to restore a good grinding surface (d).

9. A chisel properly honed several times will develop a straight bevel (c).

10. The combination square does the work of a rule, square, depth gauge, and level but does not do the work of dividers (b).

11. The blade of a spoke shave is ground and honed in the same manner as the blades of the plane bit and chisel, except that for spoke shaves a slipstone is more desirable (b).

12. The length of the plane determines the straightness of the cut, and the jointer plane is the largest of the family (b).

13. Every tooth will be bent a little to give the blade sufficient clearance. For a hand saw, the set should be half the thickness of the blade (d).

14. The try square is used as a testing tool (b), when squaring up wood stock. The remaining three choices are leveling tools.

15. A nail set will put the nail below the surface of the board, thus preventing hammer marks, called "cat paws" (a).

16. The plane is a smooth facing tool, and it is used for smoothing wood surfaces (c).

17. The same rules apply as for wood chisels. The cutting edge of the bits should be straight on the jointer, smoothing, and block planes, but slightly curved on jack plane bits (c).

3—2

18. The half hatchet (d), a rough facing tool, is used for "rounding out" to a line or for sharpening stakes. The other choices are smooth facing tools.

19. When the chisel is badly nicked (c), it must be ground until all the nicks are removed.

20. Screwdrivers and wrenches are fastening tools. The claw hammer is a driving tool (b).

CORRESPONDENCE COURSE OF U. S. ARMY ENGINEER SCHOOL

SUBCOURSE 531-0 .... Carpentry I (Tools and Equipment).
LESSON 4 .... Woodworking Power Machinery, Ladders, and Scaffolds.

SOLUTIONS

Each exercise has a weight of 5. References are to Memorandum (Volume I).

1. *d* (par 14-26)
2. *b* (par 14-18)
3. *b* (par 12-9/10)
4. *c* (par 14-22/23)
5. *d* (par 13-4)
6. *c* (par 12-7)
7. *d* (par 12-6)
8. *d* (par 14-14)
9. *d* (par 15-3)
10. *c* (par 14-8)
11. *c* (par 16-3)
12. *b* (par 11-16)
13. *a* (par 11-4)
14. *a* (par 18-20)
15. *b* (par 18-5)
16. *b* (par 17-5)
17. *c* (par 17-8)
18. *d* (par 18-8)
19. *d* (par 18-24)
20. *a* (par 18-19)

For further explanation see Discussion.

DISCUSSION

Exercise:

1. A steel guidepost is used with a shaper machine in order to start a cut without getting kickback (d).

2. During faceplate turning, the metal faceplate (disk) is screwed on the shaft of the headstock (b).

3. Rabbeting, beveling, and edging are done on the jointer by adjustments of the fence (b).

4. The solid headcutter has a disk of steel with three blades, and the flat knife cutter has two blades (c).

5. Spindle sanders are circular in shape and some are designed to move the spindle up and down as well as turn it (d).

6. A pusher board should be used when planing wide flat work on the jointer machine (c).

7. Only the jointer machine has the parts that are listed in the exercise (d).

8. The tool rest is adjusted so that it is parallel to and about 1/8" from the outer edge of the stock (d).

9. The spacing gauge, with its stops, is located above the fence and is used to regulate the length and spacing of mortises (d).

10. Round point chisels are chiefly used on faceplate turnings and concave recesses (c).

11. This portable (oscillating) sander does not leave swirl marks and it can be used with a felt pad to rub down finishes to a high gloss (c).

12. Saw guides, located above and below the table, hold the blade steady and prevent it from wobbling (b).

13. The dado head contains two 1/8" thick outside blades and an assortment of inside chippers of different thicknesses (a).

14. Toe boards are constructed of 2 x 4 material and run the full length of the platform (a).

15. Spacing of uprights depends upon the weight supported by the platform, but usually the spacing is from 7 to 10 feet (b).

16. Sections of a ladder must overlap for 5 feet for any extension over 45 feet, but a ladder must not be extended over 60 feet (b).

17. Step ladders should not be used as substitutes for workstands and no step ladder should be higher than 20 feet (c).

18. The platform is usually constructed to accommodate five 2 x 10 inch planks (d).

19. At the end of the day's work (d) remove all tools, material and debris from the scaffold.

20. The guardrail is held in place by a special section of the stirrup, and this places the guardrail about 40 inches above the platform (a).

4—3

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MEMORANDUM 531-0

CARPENTRY I

(TOOLS AND EQUIPMENT)

U.S. ARMY ENGINEER SCHOOL
FORT BELVOIR, VIRGINIA

3-8

MOS: 51B20

EDITION 0 (NRI 011)

28

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INTRODUCTION

1-1. Throughout the world stand monuments reflecting the skills and ingenuity of generations past. The Sphinx in Egypt, the Panama Canal in Central America, and the Golden Gate Bridge in our own country are only a few among many too numerous to mention. Man has progressed immensely since the pyramids of Egypt were built. This progress will continue so long as the peoples of the world strive to improve themselves by greater deeds in the field of construction.

1-2. The Army operates many installations throughout the world. Most of these installations are constructed by commercial contractors, but alterations, additions, and maintenance are performed by soldiers like yourself working in the construction and utilities career field. In this career area we build for ourselves and for future generations. There is no greater proof of your ability than a "job well done." It is like a monument — you being the sculptor — created by your skill and leadership. Constant effort for improvement brings added rewards and satisfaction to you and to those for whom you build. A man who is conscientious in what he does, and how he does it, becomes a skilled tradesman — a master of his craft.

1-3. This memorandum is part of a planned program which will enable you as a carpenter to progress through jobs of increasing difficulty. It will familiarize you with the basic tasks of an Army carpenter and it will introduce you to job safety. It will examine the use of working drawings and prints, handtools, power machinery, and scaffolds. Your rate of advancement will depend on you, your ability, and your willingness to apply yourself.

JOB SAFETY

2-1. A carpenter's duties include working with hand and power tools, using ladders and scaffolds or handling long and heavy pieces of lumber. These duties suggest some of the areas where good safety practices and safe working conditions are just as important as skill in fabrication, erection or maintenance. Safety, then, is a very important factor in the completion of all your assigned tasks no matter how simple the job may seem to you. A job may be limited in complexity or be quite elementary in skill requirements, but the area in which the work is performed may require an alertness to safety principles not directly indicated by the extent of the carpentry work involved.

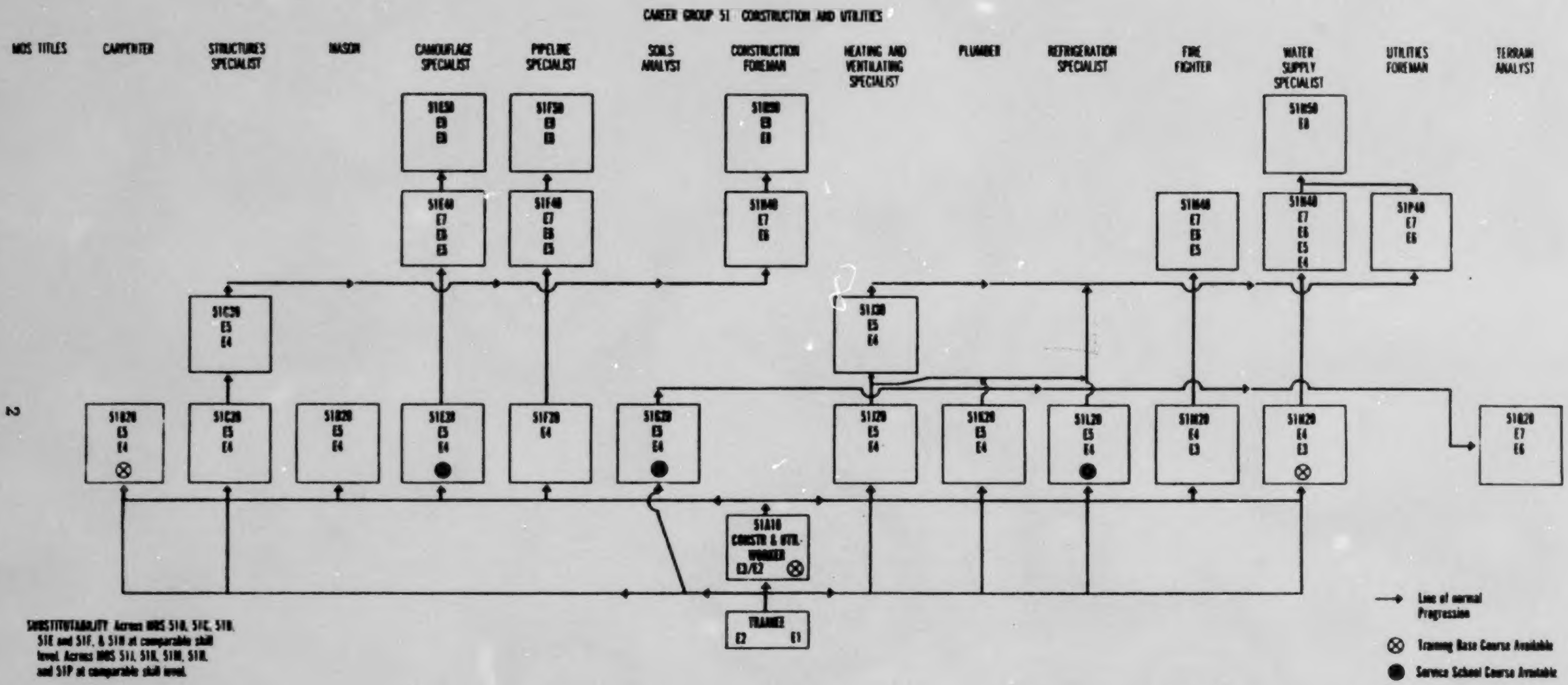
2-2. On some jobs you have to give close attention to signals and warning signs, the stacking of lumber, the use of pilings or poles, the disposal of waste materials, the location of other workmen and similar safety considerations. You can expect a carpenter to require hoisting equipment in the course of his work and to be concerned with the strength and endurance of ramps, runways, platforms, and scaffolds, and to insist that the choice, condition and use of ladders conform to acceptable and prevailing safety rules.

2-3. Each individual is personally responsible for good safety practices and the prevention of accidents. This chapter will emphasize those areas where safety requirements of specific importance to you, the military carpenter, must be observed. It will instill in you a positive attitude towards safety. It will also attempt to provide you with the necessary information and guidance to assure an accident-free completion of even the smallest job.

2-4. If you adopt as your code the practice of good safety, you will find that it has many outlets and many faces and is present in everything you do, and since your job takes up a large part of your time, safe habits formed on the job can carry over to your recreation and leisure time as well.

3-1. If you haven't had an accident during your service career, you are probably wondering why so much emphasis is being placed on safety. Unfortunately, accidents sometimes happen to individuals who have never had an accident; therefore, it is necessary to keep everyone safety conscious. Safety is stressed because hundreds of lives are lost, many people are injured (some are crippled for life), and many dollars are lost to the Army each year because personnel fail to observe the safety rules.

3-2. As a workman in the construction field, you must remember that work you do and the way you do this work affect not only you but also your co-workers and the personnel who use the structures that you construct and maintain. If you are careless when you work, you may injure yourself, your co-workers, or other personnel nearby. If you do your work so that it will not stand up under the stresses imposed upon it, it may collapse with you on it, fall on someone, or later injure or kill the users of the structure. All of these mishaps may be prevented if you will


CAREER GROUP 51 CONSTRUCTION AND UTILITIES
MOS TITLES
CARPENTER
STRUCTURES SPECIALIST
MASON
CAMOUFLAGE SPECIALIST
PIPELINE SPECIALIST
SOILS ANALYST
CONSTRUCTION FOREMAN
HEATING AND VENTILATING SPECIALIST
PLUMBER
REFRIGERATION SPECIALIST
FIRE FIGHTER
WATER SUPPLY SPECIALIST
UTILITIES FOREMAN
TERRAIN ANALYST
51E50 E9 E8
51F50 E9 E8
51H50 E9 E8
51N50 E8
51E40 E7 E6 E5
51F40 E7 E6 E5
51H40 E7 E6
51M40 E7 E6 E5
51N40 E7 E6 E5 E4
51P40 E7 E6
51C30 E5 E4
51J30 E5 E4
51B20 E5 E4
51C20 E5 E4
51D20 E5 E4
51E20 E5 E4
51F20 E4
51G20 E5 E4
51J20 E5 E4
51K20 E5 E4
51L20 E5 E4
51M20 E4 E3
51N20 E4 E3
51Q20 E7 E6
51A10 CONSTR & UTIL WORKER E3/E2
TRAINEE E2 E1
Line of normal Progression
⊗ Training Base Course Available
● Service School Course Available

SUBSTITUTABILITY Across MOS 51B, 51C, 51D, 51E and 51F, & 51H at comparable skill level. Across MOS 51J, 51K, 51M, 51N, and 51P at comparable skill level.

Figure 1. MOS 51 career field.

use good judgment and the safety standards outlined in this section.

3-3. **Building Maintenance Safety.** In the 51 career field (fig. 1) the job you do and the way that you do it are of great importance to the Army. No one, be he a four-star general or basic soldier, can do an outstanding job without being safety conscious. Therefore, it is our prime task in this section to teach you those safety standards that are of particular importance in your job.

3-4. Since a large number of carpenters are concerned with maintenance and repair, take a typical building and go over it from the foundation up. An excellent structure for our purpose is a two-story wooden barracks built on a concrete foundation. A well-built foundation is practically maintenance-free and offers little in the way of safety hazards. So, we will start at the top of the foundation and work our way up, looking for and safely correcting the defects we find.

3-5. These defects are often concealed. Floor joists can appear safe, but when a load is placed on them, they can give way because of rot or damage by termites. When you inspect and find rotten or deteriorated floor joists, brace or repair them as soon as possible. If they are loaded (this is especially important in storage rooms and warehouses), you should reduce these loads to below published safe maximums until you can make adequate repairs.

3-6. Framing timbers are other parts of our structure where defects are frequently concealed. This is because the timbers are covered on the outside with a weatherproof covering of some type, and the inside is covered with sheetrock, plaster, or some other covering. Even though they are concealed, they are, so to speak, the superstructure of our building. If they are rotten, damaged by termites, or broken by storms, the whole building can collapse. When you find any signs of the above defects in framing timbers, you should repair them at once. If the job is too large, bring the defects to the attention of your supervisor.

3-7. Doors are easy to check for defects since they are in the open. However, even though they are in the open and easy to see, there is much to inspect and correct on them. Exit doors should always be inspected to see that they open outward, are well lighted, and marked as exits. If they are on a large barracks or public assembly building (in addition, any building with an occupancy of more than 150 persons), they should be equipped with panic hardware (a catch release bar all the way across the door). When it is necessary for you to block a door, place a sign on the opposite side, indicating "Door Blocked."

3-8. Broken window glass and sticking windows are common building hazards. As construction workers, we can eliminate these hazards by keeping windows operating easily and replacing broken window glass promptly. Keeping windows operating easily will keep personnel from struggling to open them, breaking a pane of glass, and cutting themselves. Replacing broken glass promptly will insure that personnel do not cut themselves.

3-9. Now we come to the worst building hazard — stairs. Falls suffered by personnel ascending or descending stairs are the most common of all building accidents. These falls are usually caused by undue haste, poor stair illumination, and defective or improperly designed steps. You can help to reduce these accidents by constructing and maintaining stairs to the following standards.

3-10. The preferred slope for a stairway is between 30° and 35° from the horizontal. A tread width of not less than 9½ inches and a nonslip nosing of 1 inch are recommended. The riser height should not be more than 8 inches nor less than 5 inches, and it should be constant for each flight. You should not construct a stairway less than 20° nor more than 50° from the horizontal. Where the slope is less than 20°, you should install a ramp instead of stairs. You should insure that all stairs, landings, and platforms are of sufficient strength to sustain a live load of not less than 100 pounds per square foot with a safety factor of four. Also, stair width should be such that the maximum traffic can be accommodated without jamming.

3-11. Stair surfaces should be kept in good repair. Upon detection, you should immediately repair or replace loose boards, insecure treads, protruding nails, and torn or worn stair treads.

3-12. You should provide handrails on all stairs having four or more steps, and on both sides of stairs which are wider than 4 feet. In addition to side rails, you should install a center railing on stairs wider than 88 inches. All of these railings should be strong enough to withstand a thrust of 200 pounds at any point along the top rail. When stairwells are open, you should place second rails between the steps and the upper rails to act as toeboards and protection against falling through the railings.

3-13. Our last part of the building is the roof, including the trusses. Trusses are a part of the superstructure of the building. They support the roof and add strength to the walls. Many of these trusses are bolted together. They are inspected from inside the building — the attic in barracks and like buildings, and from a long ladder, crane, or other lifting device in hangars and similar buildings. Any time you find loose bolts, slippage, or deterioration on roof trusses, you should repair them as soon as possible.

3-14. You should inspect roofs for rotten timbers and other dangerous defects and repair them as soon as possible. In addition to regular inspections, you should inspect roofs for damage after violent storms.

3-15. **Woodworking Shop Safety.** A large number of Army personnel and civilian workers are injured in Facilities shops each year. Some of these casualties are visitors or workers detailed from some other unit to work in the shops. These visitors/workers are often unaware of the hazards that are present in a shop. Even the men who work in the shops are sometimes aware of these hazards only after they are injured. Then they are well aware of them! As the saying goes, "Better late than never." However, there is a better way. This "way" is presented in the following paragraphs. So, whether you visit or work in the shops that we discuss, you should observe the safety practices that are presented.

3-16. Probably more fingers are lost in the woodworking shop than in any other shop on the post. The reason for this is that the machines in this shop operate at very high speeds, and personnel do not always follow the safety rules for operating these machines. Following these safety rules may very well keep you from losing your fingers or even your life.

3-17. Only properly trained and authorized personnel are permitted to operate woodworking machinery. Signs or decals stating "Authorized Personnel Only" are posted on shop equipment. If you are authorized to operate these machines, you should not wear loose clothing, neckties, jewelry, or other articles which could become tangled in their moving parts.

3-18. You should not clean or repair any woodworking machine while it is operating. When cleaning or maintenance is necessary, you should completely stop the machine and tag and lock the control switch in the OFF position.

3-19. You should keep shop floors in good repair and free of sawdust, wood scraps, or other objects which could cause you or your fellow workers to slip or stumble and fall into a woodworking machine. Also, adequate working space should be provided around the machine. Anti-slip footing should be used on the floors.

3-20. Wear heavy aprons, hand pads, and other equipment when there is danger of your being hit by pieces of stock or where splinter hazards exist. Also, wear goggles or face shields during sanding and grinding operations and when working on wood lathes and power saws.

3-21. The following operating standards should be carefully observed when you use a power saw:

- Keep all guards in place.
- Use pusher sticks to prevent injury when sawing short or narrow pieces of work.
- Keep your hands out of the line of cut while feeding stock.
- Hold stock against a gauge or fence; never saw it freehand.
- When ripping with the fence gauge close to the saw, or when ripping short or narrow stock, always use a push stick.
- When ripping, stand out of the line of the stock being cut; make sure your fingers and hands are out of the danger area.
- Never crosscut long stock on a table saw.
- Clean sawdust and slivers from the saw with a brush; never clean with your hands, a rag, or compressed air.
- Keep all cutting tools sharp and in good condition at all times, and repair or replace defective tools immediately.
- Shut off the woodworking machines when you leave them.
- The woodworking shop is not the place for horseplay. This may distract an operator's attention while he is working on a moving machine.
- Insure that woodworking machines are equipped with effective suction hoods, connected to an exhaust system, designed to efficiently remove and prevent the accumulation of flammable wood dust.
- Good lighting is an important safety item in all woodworking shops. You should insure that lighting systems are installed to existing standards to provide adequate illumination at all points where work is being done.
- Electrical switches for operating equipment should be within your reach, but not where they can be accidentally turned on or off.
- All electrical installations should be grounded according to approved standards.
- Suitable racks should be provided near each machine for storage of the various jigs, fixtures, and parts used with the machine.

- Aisleways throughout the shop should be plainly marked and kept free of all materials and debris.
- You should store and handle all wood stock and materials, including scrap, to avoid creating any kind of personnel hazard.

3-22. Circular saws can be used effectively for many different types of woodcutting jobs. However, when you use them improperly without guards, these saws are extremely dangerous.

3-23. Cracked or defective saw blades are not to be used. You should inspect circular saw blades frequently to make certain that no defects have appeared. Before each sharpening, inspect these blades by the use of the fluorescent penetrant, TYGOH, or an approved magnaflux method. Discard any blades that you find to be defective.

3-24. Most cracks in saw blades begin in the teeth gullets. If you use cracked blades, the cracks may grow larger so that the blades eventually break apart. The following precautions will help to prevent blades from cracking:

- Keep the blade tightened for the speed at which it is to operate. If it is too loose, the blade may vibrate, heat, expand, and crack.
- The teeth should have enough set (set is the outward bend on the ends of the saw teeth) to provide sufficient clearance to prevent burning. If the blade becomes hot, it can expand and crack.
- The saw should be round, the rim should be concentric with the eye, and the saw should be perfectly balanced, or it may wobble and crack.
- Keep saw blades sharp. If the blade is not cutting properly, it will pound its way through the wood and will eventually crack.

3-25. Circular saws should be provided with a spreader to prevent stock from kicking back, and the blades should be guarded by hoods that automatically adjust to the thickness of the stock being cut. The portion of the blade below the cutting table should be completely inclosed or guarded by a rigid exhaust hood.

3-26. Ripsaws should be equipped with antikickback dogs hinged to the hood. The points of the dogs ride on the stock to keep it from being forced up and back toward you. Kickbacks on ripsaws usually result from one of the following causes:

- Failure to use a spreader.
- Improperly conditioned blade, allowing stock to pinch and rise off the table.
- Improper gauge or fence alinement.
- Improperly seasoned or twisted-grain lumber.
- Improperly designed or mounted antikickback dogs.

3-27. Properly designed antikickback dogs are used on all circular saw operations. On a saw where the arbor is above the table, the rotation of the blade is reversed. On this type of saw, it is necessary to locate the fingers of the antikickback dog ahead of the blade to prevent the stock from rising.

3-28. On rabbeting and dadoing jobs, it is impossible to use a spreader. Often it will be necessary to remove the blade hood. These operations can be guarded by a jig which slides in the grooves of the transverse guide. The work can be locked in the jig and your hands kept clear of the blade. The standard blade hood guard should be replaced immediately after rabbeting or dadoing work is completed.

3-29. Overhead swing saws are equipped with a mechanical device to prevent the front end of the saw from traveling beyond the front edge of the table. A return mechanism is also provided which automatically returns the saw to the back of the table when released at any point in its travel. A self-locking device is installed to keep the saw from rebounding when released. A self-adjusting guard completely incloses the upper half of the arbor end and the point-of-cutting, regardless of the position of the saw. If any of these are inoperative, or not installed, the saw should not be operated until it is made safe by repairing it or by installing the missing safety devices.

3-30. The operating standards for a power saw, given in the preceding paragraphs, are an example of the safety precautions you must observe in the operation of a piece of power equipment. Each piece of equipment will have certain precautions to be observed while you are operating that piece of equipment. These precautions and rules are given in EM 385-1-1, *General Safety Requirements*. Remember that you must be qualified and authorized to operate your power equipment. You must learn to operate it by working under the close supervision of someone who is already qualified. Another thing to remember is that all electrical portable power equipment or tools must be grounded according to the requirements of the National Electrical Safety Code. When grounds are not part of the power cable, complete bonds will be made between the conductor and the tool and the conductor and the ground by the use of an additional wire to ground the tool effectively.

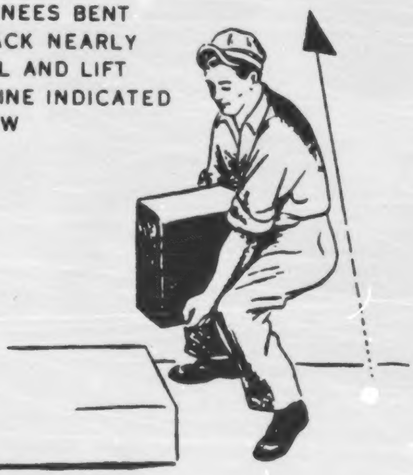
3-31. Construction Site Safety. The previous two boldface headings presented safe practices for some of the construction job area. But they did not give you all of the hazards and safety practices of construction. A construction project presents many hazards. Excluding a public highway, a construction site it probably the most dangerous place you will ever see.

3-32. To illustrate the point, let's visit a building construction site that is typical of changes and alterations required at an Army installation.

3-33. Let's start with the loading of a 1½-ton truck with miscellaneous building materials in preparation for the trip to the site. Included in these materials are three 50-pound boxes of nails and some long lumber. We must also carry some workmen to the job. We will use them to help us load the truck.

3-34. To load the boxes of nails, we will lift them as illustrated in figure 2. Notice in this illustration that the lifting is done with the legs and not with the back. If we were to lift the nails with our back, it would invite a back injury. This practice of lifting with our legs also applies to lifting and loading our other materials.

3-35. We must load our lumber (16 feet long) onto the truck bed, which is 12 feet long. We will put one man on the truck and one man lifting either end of the lumber. The man nearer the truck will hand his end of the lumber to the man on the truck, and the one on the other end will push the lumber onto the truck. Our man on the truck will then neatly stack it, but not so high that it will fall over and injure someone. A 16 foot 2 x 8 can easily mash a toe. After we finish loading our lumber, we place a red flag (any kind of red cloth) on the end of the lumber sticking out of the truck. This will make it easy to see and possibly keep someone from running into it.



WITH KNEES BENT
KEEP BACK NEARLY
VERTICAL AND LIFT
ALONG LINE INDICATED
BY ARROW

Figure 2. Proper lifting method.

3-36. Now that we have the lumber flagged, we complete the loading by neatly stacking our other materials onto the truck, remembering that we must make a place for the workmen to sit.

3-37. When we have completed loading our materials, we let the workmen get onto the truck and sit down. We must insure that none of them sits on the part of the lumber that sticks out from the truck bed. Also insure that they do not sit on the back of the bed with their feet hanging off. The best place for them to sit is in the front of the truck bed, with their backs to the cab. This will prevent their being thrown forward if we have to stop fast. Of course, we know that if they stand up, they may be thrown down and injured when we make a turn. So we instruct them not to stand up during our trip to the work site.

3-38. Now that the truck is loaded, we must back it out and start for our destination. Be sure that you always have someone guiding the truck while it is being backed into traffic.

3-39. In previous paragraphs a truck that was hauling construction materials was referred to. The loading of this truck, its movement to the construction site and the unloading procedures all involve safety considerations. Both the truck and the driver, who might be you, incidentally, are also subject to the rules of safety. It would probably be well to consider some of the pertinent rules that apply in this instance.

3-40. There were certain operations that the driver had to perform before he moved his truck. You will assume that he would perform the customary before-operation check, including brakes, horn, lights, oil level, tires, etc.

3-41. Since the vehicle is also equipped with gauges, speedometer, mirrors, etc., all of these must be included in his performance checks as safety precautions. Why check the fuel gauge, for instance? Is this a safety precaution? Indirectly it is, for if you run out of fuel on a state highway, it could be embarrassing to have to leave a military vehicle unattended in a no-parking zone. Oil level has a similar bearing on safe operation.

3-42. Seasonal weather conditions likewise have a definite impact on safe vehicle operations, since fog, ice, sleet, snow and heavy rains all produce hazardous conditions that merit thoughtful consideration on the part of all vehicle drivers. Again, safe practices that are habitual on the part of the military vehicle driver will usually carry over when he drives a civilian vehicle.

3-43. Since carpenters and construction workers are expected to go into areas where only unimproved roads or paths exist, the vehicle driver must be experienced and have sufficient good judgment to assure the safe transportation of personnel and materials into these areas.

3-44. The above are some of the safety considerations imposed on the use of vehicles to haul construction materials. On those occasions when men ride on the cargo bed of the truck, they are prohibited from riding with arms or legs extended outside of the truck body, in a standing position, or seated on top of the truck cab or on the load.

PQRSC PLAN

PREVIEW –	Read the chapter through the first time quickly.
QUESTION –	Ask yourself: what are the objectives of the chapter that you are reading.
READ –	This is the third and most detailed reading.
STATE –	State answers in your own words as you read.
CHECK –	Compare your answers and reasons with the solution and discussion given.

Figure 3. Safe study tips.

3-45. Upon nearing the building site, we observe a great amount of activity. There are about 20 men already working on the building. Ordinarily, there would not be this many men working on a building of this size, but this is a high priority project and must be completed as soon as possible.

3-46. As we arrive, we see that the building (single-story supply facility) is nearing completion. It should be completed in a few days — except for trim, paint, etc.

3-47. We meet the sergeant in charge of the construction. After the introductions, he takes us over to the temporary office and materials storage building and issues us a safety "hard" hat. He explains that a hard hat is necessary in this area because of the number of men working on the building. Then he tells us to adjust it to our head and make sure that there is at least 1¼ inches between our head and the inside crown to provide suitable cushioning effect. (This is done by adjusting the inside cradles or hammocks.) He also tells us that these hats have already prevented several head injuries.

3-48. The sergeant instructs the men that we brought on the truck to unload the materials. He tells them to put the nails and other small materials in the temporary building so that they will be protected from the elements and won't become a tripping hazard. He also tells them to stack the lumber near the building which is under construction, where it will be used shortly on another building to be constructed.

3-49. Let's take a look at the new building. The sergeant has done a fine job of keeping the area clean and orderly. There isn't any lumber with nails in it lying around, or any broken bricks or trash of any kind. This makes conditions much safer for the personnel in the area. There is a scrap pile out back where the discarded materials, etc., are thrown.

3-50. Let's stop and watch these workmen in the loose clothing handle the hot tar. They are using it to put a built-up roof on the building. (A built-up roof consists of alternate layers of building felt and hot tar.) The tar in the tar kettle is heated to more than 200° F. Let's stand over here by the fire extinguisher. It is placed here, approximately 50 feet from the tar kettle, so that it can be used in case the kettle catches fire. This type of tar kettle often catches fire. One thing that frequently starts fire in the kettle is water which is accidentally put into the kettle along with the tar. Sometimes this water is just moisture or dew on the tar, but it causes the tar to boil over onto the kettle firebox.

3-51. We must stand back out of the way, because we are not wearing proper clothing and gloves like those of the workmen who are handling the tar. The loose clothes and gloves give the workmen a degree of protection. If we were to get some hot tar spilled on us, we would get severe burns. Don't get near the beam and ley where they are hoisting the tar onto the [illegible].

3-52. Now, let's go inside the building where they are putting up the plywood room partitions. Good plywood produces a beautiful finished wall when it is varnished. The workman sawing and fitting the plywood is using a power handsaw. (Plywood is difficult to saw with a manual handsaw.) The spring-loaded blade guard is in place, and the carpenter is holding the saw to one side so that he will not cut himself. He is wearing goggles to keep the sawdust out of his eyes. He appears to be following good safety practices.

3-53. The floor is clear of waste. Everything in here appears to be running smoothly, with no violations of construction safety practices, so let's go back outside and watch the masons lay bricks. The roofing crew has just finished its work, so the bricklayers can now start. It wouldn't have been a safe practice to lay bricks while the roofing men were applying hot tar on the roof.

3-54. As we come to the workman mixing mortar, we see that he is wearing gloves and a respirator. The gloves are to protect his hands against the chemical effects of the cement, and the respirator keeps him from inhaling the dusty cement. (Cement is so fine that it will pass through a sieve having 40,000 openings per square inch.)

3-55. When we approach the building, we see that the bricklayers are also wearing gloves to protect their hands. This protection is twofold. One is protection from the chemical effects of the cement, and the other is protection from the roughness of the bricks.

3-56. Later, the brick crew must remove the mortar stains from the bricks, but we won't stay here long enough to see this operation. There are two methods that they can use to do this. The first one is by sandblasting the bricks with fine sand. If they use this method, they must wear goggles to protect their eyes from flying sand particles. The second method is by washing the bricks with a muriatic acid-water solution. This method requires that goggles, rubber gloves, an apron, and boots be worn for protection from the acid.

3-57. As you can see, there are many hazards on a construction job. But, for each hazard there is a safety practice that will protect you from injury. In many cases, this safety practice is nothing more than being careful and using good judgment.

4-1. Abbreviations

The following abbreviations in connection with lumber are used by the carpenter:

AD	air-dried
a.l.	all length
av.	average
av. w.	average width
av. l.	average length
bd.	board
bd. ft.	board foot
bdl.	bundle
bev.	beveled
b.m.	board (foot) measure
btr.	better
clg.	ceiling
clr.	clear
CM	center matched; that is, tongue-and-groove joints are made along the center of the edge of the piece.
Com.	common
Csg.	casing
Ctg.	crating
cu. ft.	cubic foot
D & CM	dressed (one or two sides) and center matched
D & M	dressed and matched; that is, dressed one or two sides and tongued and grooved on the edges. The match may be center or standard.
D. S.	drop siding
D & SM	dressed (one or two sides) and standard matched
D 2S & CM	dressed two sides and center matched
D 2S & M	dressed two sides and (center of standard) matched
D 2S & SM	dressed two sides and standard matched
Dim.	dimension
E.	edge
FAS	firsts and seconds, a combined grade of the two upper grades of hardwoods.
f. bk.	flat back
fcty.	factory (lumber)
F. G.	flat grain
Flg.	flooring
f. o. k.	free of knots
Frm.	framing
ft.	foot or feet

Hdl.	handle (stock)
Hdwd.	hardwood
Hrt.	heart
Hrtwd.	heartwood
in.	inch or inches
KD.	kiln-dried
k. d.	knocked down
lbr.	lumber
lgr.	longer
lgth.	length
lin. ft.	linear foot; that is, 12 inches
L. R.	log run
Lr. MCO	log run, mill culls out
M.	thousand
M. b. m.	thousand (feet) board measure
MCO	mill culls out
Merch.	merchantable
M. R.	mill run
m. s. m.	thousand (feet) surface measure
m. w.	mixed width
No.	number
1s & 2s	ones and twos, a combined grade of the hardwood grades of firsts and seconds.
Ord.	order
P.	planed
Pat.	pattern
Pky.	picky
Pln.	plain, as in plain sawed
Pn.	partition
Qtd.	quartered (with reference to hardwoods)
rd.	round
rdm.	random
res.	resawed
rfg.	roofing
Rfrs.	roofers
rip.	ripped
r. l.	random length
r. w.	random width
S & E	surfaced one side and one edge
S2S & M	surfaced two sides and standard or center matched
S2S & SM	surfaced two sides and standard matched
Sap.	sapwood
S1E	surfaced one edge
S1S1E	surfaced one side and one edge
S1S2E	surfaced one side and two edges
S2E	surfaced two edges
S4S	surfaced four sides
S & CM	surfaced one or two sides and center matched
S & M	surfaced and matched; that is, surfaced one or two sides and tongued and grooved on the edges. The match may be center or standard.
S & SM	surfaced one or two sides and standard matched
S2S & CM	surfaced two sides and center matched
Sap.	sapwood
SB	standard bead
Sd.	seasoned
Sdg.	siding
Sel.	select
S. E. Sd.	square-edge siding
s. f.	surface foot; that is, an area of 1 square foot
Stfwd.	softwood
Sh. D.	shipping dry
Ship	shiplap
Sm.	standard matched
s. m.	surface measure
s. n. d.	sap no defect
snd.	sound
sq.	square
sq. E.	square edge
sq. E. & S.	square edge and sound
sqrs.	squares
Std.	standard
stk.	stock
S. W.	sound wormy
T & G	tongued and grooved
TB & S	top, bottom, and sides
tbrs.	timbers
V. G.	vertical grain
w. a. l.	wider, all length
wdr.	wider
wt.	weight
wth.	width

CHAPTER 2

Working Drawings and Building Materials

THE ENTIRE STORY of construction projects can be read in the lines, symbols, and notes of the blueprints for a job. Because of this, it is necessary that you be able to read and interpret into a task, a material, a function, or a specification to be met every item of information in the print.

2. Architectural drawings are divided into two general classes: primary drawings, which consist of design sketches and drawings for display purposes; and working drawings (blueprints), which consist of views (flat surface line drawings) giving detailed information necessary for actual construction of the building. The construction of a building is described by a set of drawings which gives a thorough graphic description of each part of the operation. Usually, a set of plans begins by showing the boundaries, contours, and outstanding features of the construction site. Succeeding drawings give instructions for erecting the foundation and superstructure; installation of lighting, heating, and plumbing; and details of construction required to complete the building. Although these drawings are prepared in accordance with the general principles of right-angle projections (projections in which the projecting lines are perpendicular to the plane of projection), they differ from other drawings in certain practices. Therefore, as an approach, let's take a brief look at the various types of drawings.

5. Working Drawings for Buildings

5-1. This section will teach you how to interpret and identify the different types of working drawings that you may encounter on the job. Items to be covered are:

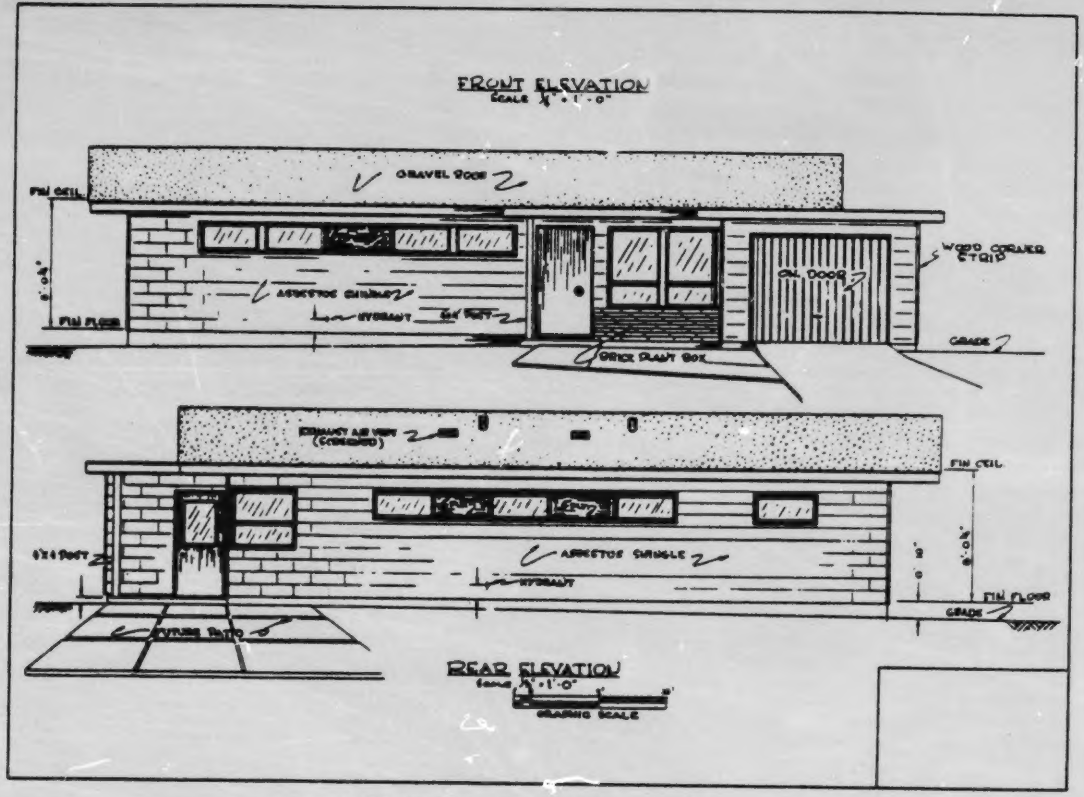
- Plot plans.
- Foundation plans.
- Framing plans.
- Floor plans.
- Elevations.
- Sections and details.
- Drawing details.
- Symbols and terms.
- Common abbreviations.
- Specifications.

5-2. The working drawings of a structure are presented in general and detail drawings. General drawings consist of plans and elevations; detail drawings are made up of sectional and detail views. Since it is the purpose of working drawings to be exact about shape and size, working drawings are generally scale-size projects. In some instances, a proportional-size detail drawing may be included to show how parts look when they are assembled.

5-3. In architectural drawing, "plan" views are obtained looking down on the object with a vertical line of sight. Plan views correspond to top views and involve only horizontal dimensions of width and depth. Any view involving vertical dimensions is an "elevation." This could be a front view, side view, or any other elevation view, as shown in figure 16. Different elevations are indicated as front, right, etc., or according to the direction from which the view is taken. Note the writing on figure 16 which gives the type and size of materials used in construction. This writing is called construction notes and is usually found at the bottom of the print. The graphic scale is usually located in the lower right corner of prints. In this drawing it is located in the bottom center, and the scale shows that ¼" in this drawing is equal to 1' - 0".

5-4. Because of the size of the object being represented, different scales are used for general and detail drawings. In general, plan views and elevation views are drawn on separate sheets in order to make the view large enough for practical use. Detail views, drawn to a larger scale, furnish information not provided on general views. They are strategically placed on the main views and on additional sheets as needed to give the worker a complete picture of the structure.

5-5. **Plot Plan.** A plot or site plan shows the boundaries of the construction site and the location of the building in relation to the boundaries.


FRONT ELEVATION
SCALE ¼" = 1' - 0"
GRAVEL ROOF
FIN CEIL
8'-0½"
FIN FLOOR
ASBESTOS SHINGLE
HYDRANT
GAS VENT
WOOD CORNER STRIP
OH. DOOR
GRADE
BRICK PLANT BOX
EXHAUST AIR VENT (SCREENED)
FIN CEIL
4"x4" POST
ASBESTOS SHINGLE
HYDRANT
8'-0"
FIN FLOOR
GRADE
FUTURE PATIO
REAR ELEVATION
SCALE ¼" = 1'-0"
GRAPHIC SCALE

(Figures 4 to 15 inclusive not used)

Figure 16. Elevations.

It also shows the ground contour, roads and walks, and locates utility lines, such as sewer, water, gas, etc. These plans are drawn to scale from sketches and notes based on a survey of the area. By locating the corners of the building at specific distances from the established reference points, the plot plan gives the builder a definite starting point. A plot plan is shown in figure 17. The legend in the upper left corner of figure 17 shows the symbols for water, sewer, gas, and property lines. The arrow $(\underleftrightarrow{25' - 0''})$, located at the bottom of the plan, indicates that the distance from the curb, next to the sidewalk, to the center line of Kirk St. is 25′ - 0″. The title block in the lower right corner of the print tells you what is to be constructed and gives the meaning of different symbols used throughout the plan. The names of the persons responsible for drawing, tracing, checking, and submitting the plan are also in the title block, along with the signature of the engineer responsible for the job and the date. The scale for this plot plan is $\frac{5}{32}'' = 1' - 0''$. (See fig. 17.)

5-6. **Foundation Plan.** The foundation is the starting point in the actual construction, and a completely dimensioned plan is furnished. When a "post and wall" type foundation is used, the foundation plan may be combined with a floor-framing plan. Figure 18 shows a concrete slab foundation which has warm air ducts imbedded in the slab. Detail B of figure 18 illustrates a cross-sectional view of the duct, extending from the heating unit, under the concrete floor. The broken lines indicate the ducts and the cross (┬) shows the duct opening. Attached to the foundation plan there will be a detail sheet, which consists of the necessary details or specifications needed to complete any given job.

5-7. **Framing Plans.** Framing plans show the size, number, and location of structural members which form the building framework. Separate plans may be furnished for floors, walls, and roofs. The floor-framing plan, shown in figure 19, specifies the size and spacing of joists, girders, and columns used to support the floor. Detailed views are usually added to show the method of anchoring joists and girders to the foundation, as shown in the detail view on the right side of figure 19. Wall-framing plans show the size and location of wall openings, ceiling heights, and other details. Roof-framing plans show the construction of the rafters or trusses which span the building and support the roof.

5-8. **Floor Plan.** A floor plan, shown in figure 20, is a cross-sectional view of the building. This view is obtained by assuming that a building is cut in half horizontally, exposing every room in the building. If the building has more than one floor, a plan for each floor is drawn. The floor plan shows the outside shape of the building; the arrangement and size of rooms; the type of material; and the type, size, and location of doors and windows. In addition, it shows the heating, lighting, and plumbing fixtures.

5-9. Floor plans are usually drawn to small scales such as ¼" = 1' - 0", or 3/16" = 1' - 0". This scale is shown at the bottom of figure 20. For this reason, conventional symbols are used to indicate fixtures and materials. For complex structures it may be necessary to supply separate utilities plans to show electrical, heating, and plumbing layouts. A plumbing plan is shown in figure 21. Some of the plumbing symbols are illustrated under the legend. A symbol for a 40-gallon hot water heater is also shown.

5-10. A floor plan sheet may also contain details of construction, although these are generally presented on a separate sheet. When a detail drawing is furnished to show a particular construction, a reference is noted on the floor plan. Also shown on the floor plan are "schedules" for doors and windows. A schedule is a method of presenting notes and other construction data in the form of a table, as shown in the left lower corner of figure 20. A door schedule specifies the type, size, description, and location of each door, and a window schedule gives the same information for a window. By looking at the letter (B, for example) above or below the window symbol in figure 20, and then locating the same letter in the window schedule, you come up with the correct size and type of window—in this case 3' - 0" x 1' - 6" awning vent. The correct sizes and types of doors are located in the same manner. Through the use of standard plumbing and electrical symbols, it is easy to locate plumbing fixtures, hot and cold water lines, electrical wall and ceiling outlets, switches, types of wire, etc. These symbols are illustrated and explained later in this section. Each person having anything to do with

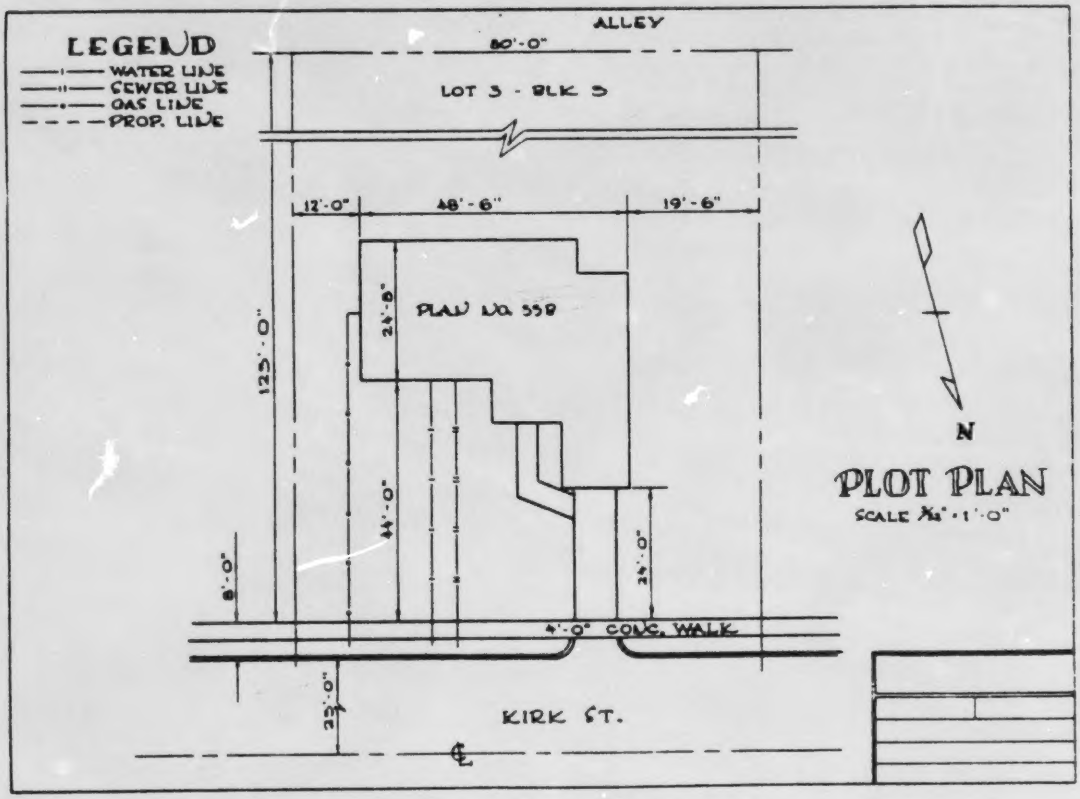


Figure 17.

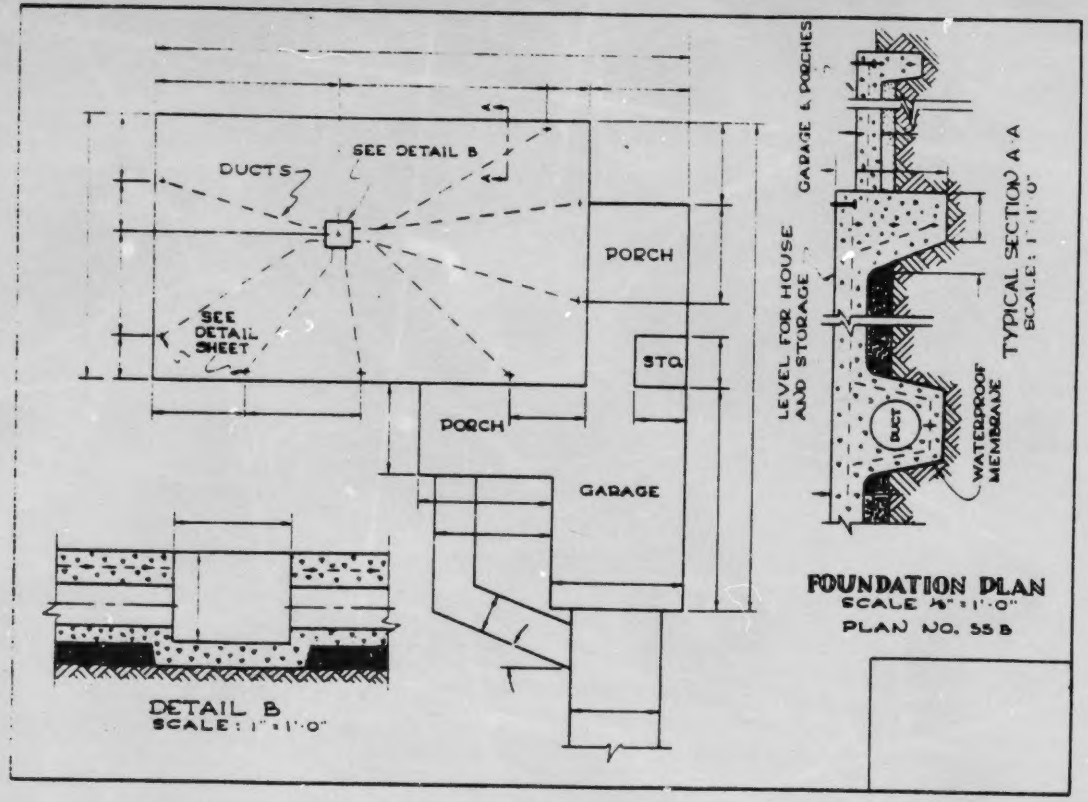


Figure 18.

the construction of a building, runway, etc., will have drawings, plans, specifications, and notes pertaining to his particular part of construction. Since all information cannot be presented graphically, construction notes are extensively used. These notes are a vital part of every construction drawing, and they must be carefully worded. There are general notes pertaining to the entire set of plans, and local notes that are important only to certain sheets or certain parts of the drawing.

5-11. **Elevations.** Elevations are exterior views of a structure and may be taken from the front, rear, right or left side. Being projections on a vertical plane, they show a picturelike view of the structure as it actually is and not as it would appear to the eye. Exterior materials; height of doors, windows, and rooms; and the surrounding ground level can be shown in elevation views. On an elevation view for a single story building, the floor level is located in reference to the surrounding ground level or "grade," as shown in figure 22. Additional floors above the first floor are located by dimensioning between finished floor surfaces. If the sides of a building are not identical, an elevation for each side must be drawn. If you had access to a plan, you could see that the dimensions given are practically all vertical measurements. However, horizontal dimensions may be placed on an elevation view if it is not possible to show them on a plan view.

5-12. Since plan and elevation views cannot be drawn as related views on one sheet (except for small structures), scaled measurements must be used for each view. However, a completed plan view may be taped in the proper position on the drawing, and the main dimensions and door and window locations may be projected to an elevation sheet.

5-13. Elevation views are made more lifelike by accenting certain lines and adding straight lines to represent the type of material used on the exterior. These representations are shown in figure 22. Lines which may be accented are window, door, roof, and building outline lines. To accent lines, one must assume that light is coming from a certain direction and that accented lines represent shaded areas. The use of straight lines to suggest the texture of exterior materials is a form of architectural "rendering." Rendering, as applied to architectural drawing, is the use of pencil, ink, water color, or a combination of these to depict a structure and bring out its form or shape.

5-14. **Sections and Details.** A section and a detail are practically synonymous; however, no view is called a detail unless it is drawn to an enlarged scale to show construction features more clearly. A south wall detail of a living room, a framing detail of a gable, and a shelf detail are shown in figure 23. The detail sections show parts of the structure with greater exactness than the small-scale section taken through the structure. When the cutting plane cuts across the narrow part of a structure or building, the view is called a transverse section. A transversal is a line intersecting any system of lines, as indicated in figure 24 (C). Sectional views taken lengthwise are called longitudinal sections. Detail sections which are usually shown are foundation, wall, door, window, or any other section considered necessary to explain the construction.

5-15. Exterior detail views, like detail sections, are large-scale drawings designed to show features which are too small or too complex to be shown in other views. They are usually developed in right-angle projection, but a pictorial projection may be used if it shows the construction to a better advantage. Important parts of detail and sectional views are the notes and dimensions to show the size of materials and the placement of parts in relation to each other. For instance, section A of figure 24 gives such details as rafter sizes (2 x 6 rafters 18" on center), sloped ceiling in the living room and kitchen, gravel roof, etc. The specifications describing the length of the rafters, amount of slope, and the thickness of the gravel roof would be included in the construction notes for the job.

5-16. *Plan views.* It is sometimes difficult to tell the exact shape of a building from the elevation views alone. For this reason, we have a plan view which shows what the structure looks like from a point directly above. This was illustrated in the floor plan and the floor-framing plan. Plan views are very simple and easy to understand, even though they contain a great amount of information.

5-17. *Detail views.* Elevation and plan views together show the major construction of the build-

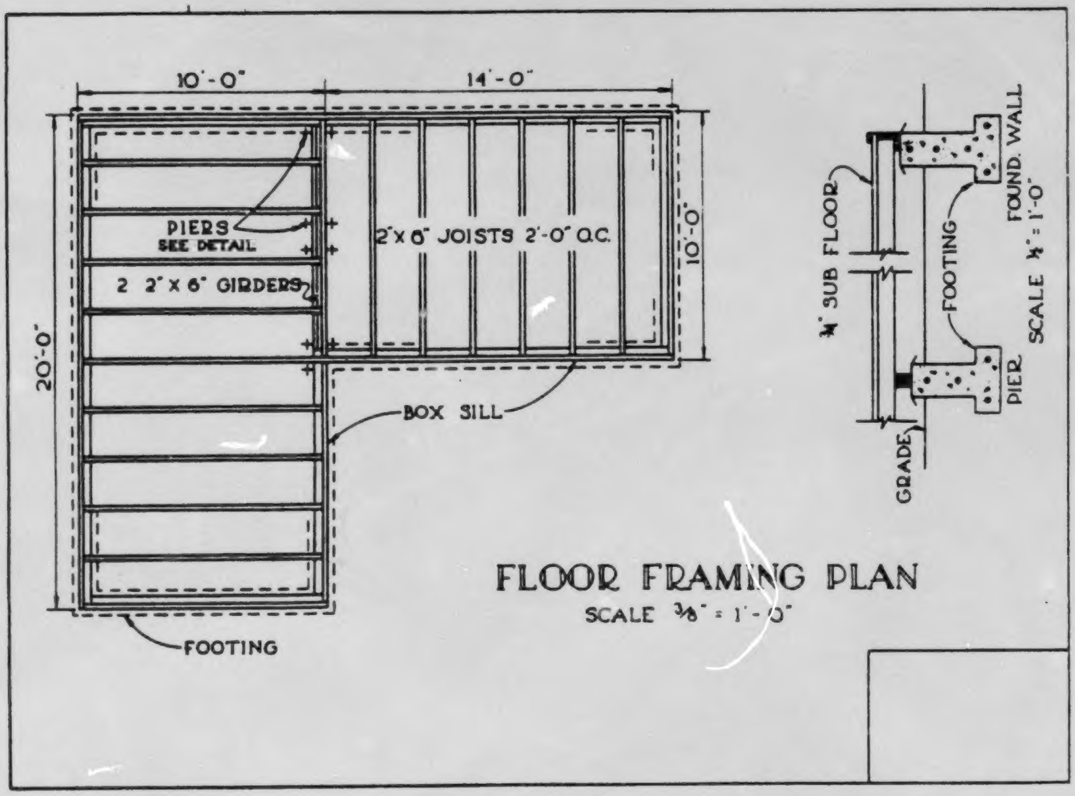


Figure 19.

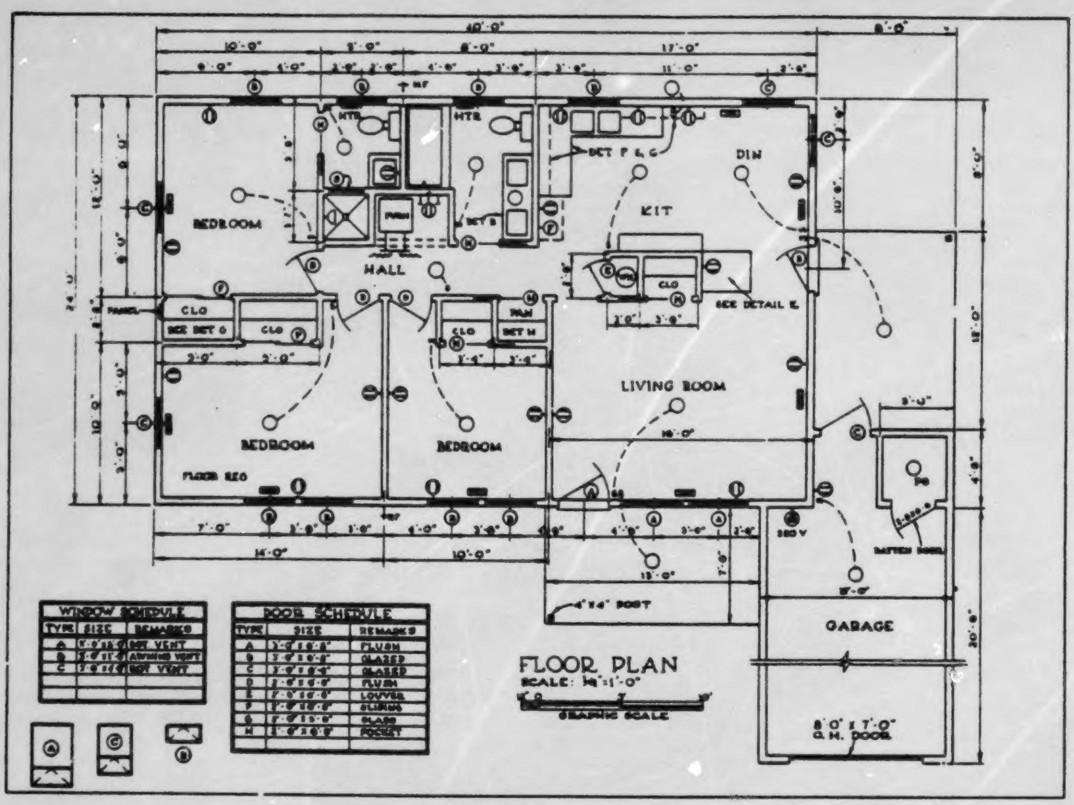

40'-0"
BEDROOM
HTR
DET F & G
DIN
KIT
HALL
CLO
SEE DETAIL E
LIVING ROOM
BEDROOM
BEDROOM
FLOOR REG
PANEL
220 V
BATTEN DOOR
4"x4" POST
GARAGE
WINDOW SCHEDULE
TYPE
SIZE
REMARKS
AWNING VENT
DOOR SCHEDULE
FLUSH
GLAZED
LOUVER
SLIDING
POCKET
FLOOR PLAN
SCALE: ¼"=1'-0"
GRAPHIC SCALE
8'-0" x 7'-0"
O.H. DOOR

Figure 20.

ing. Both of these views are too small to clearly show minor assemblies; therefore, special drawings are made showing only a portion of the main structure. These are called detail drawings because they show the most minute detail pertaining to the specific portion of the structure, as shown in figure 23. Specifications of materials, dimensions, and other information relative to construction are usually included. These drawings are made to a larger scale in order to give clearer detail. The importance of detail drawings is very easy to understand when you consider the information needed to build kitchen cabinets or stairways.

5-18. *Sectional views.* To show hidden construction features, various items are often drawn in sections, as shown in figure 24. This is done by cutting the item in the same manner that you would cut a wooden box to show the floor plan. The box is shown first with a line marking the cutting plane. A heavy dotted and dashed line is used to represent the place where the cut is to be made. The line has arrows at right angles to it, representing the direction in which the section is viewed. The section line is usually labeled "A–A," "B–B," and so on through the alphabet if several views are required. The most important value of a sectional view is that dimensions can be shown for parts that are completely hidden.

5-19. **Drawing Details.** The titles placed on drawings are very important. When they are placed on a drawing, they will be strategically placed to clearly refer to the part, detail, or view which they identify. Titles for rooms will stand out clearly near the center of the area. Titles for detail views will be carefully placed for easy reading and correctly identified according to the reference system being used throughout the set of plans.

5-20. *Dimensioning.* Dimension lines are usually unbroken between extension lines, and dimensions are given in feet and inches. The numerals are placed slightly above or in the dimension line with the reading position from the bottom and right-hand edge of the sheet. The main requirement is that dimensions be clear, definite, and unmistakable. Figure 25 shows how fractions, inches, feet, and combinations of these are specified on plans or drawings.

5-21. *Components of drawings.* The blueprint method of reproduction has been so widely used that plans of all types are now quite often called blueprints. The blueprint is the builder's guide. It is a complete diagrammatic sketch, with dimensions, of a structure to be built and contains most of the information needed by the builder. All builders must know how to read blueprints and build by them. The blueprint, as used by the builder, is made up of different types of lines showing various views with a scale and legend. Study some of the illustrations on the previous pages and note the different kinds of lines. Let's see what these lines are.

5-22. *Working lines.* The lines which represent the edges of surfaces are somewhat heavier than the other lines on the drawing and are known as working lines. These lines may be straight or curved, depending upon the shape and view of the object.

5-23. *Hidden lines.* An outline of a part which is invisible in the particular view is known as a hidden line and is represented by a series of short dashes approximately ⅛ inch in length. The space between dashes is about equal to the length of the dash.

5-24. *Center lines.* Center lines indicate the center of an object. They are also used to show the center of holes or openings in objects and curved portions.

5-25. *Extension lines.* It is sometimes necessary to lengthen or extend working lines on a drawing. These lengthened lines are known as extension lines. The end of an extension line should never join the working line which it extends.

5-26. *Dimension lines.* Dimension lines are used to show the size of a structure or any structural part. They are light lines drawn between working lines or extension lines to show the distance between two points. Each end of the dimension line has an arrowhead to indicate the point where the measurement begins and ends. The points of the arrow should just touch the line where the measurement starts and stops. Numerals which give the exact distance between the arrow points are placed somewhere in the length of the dimension line. When work-

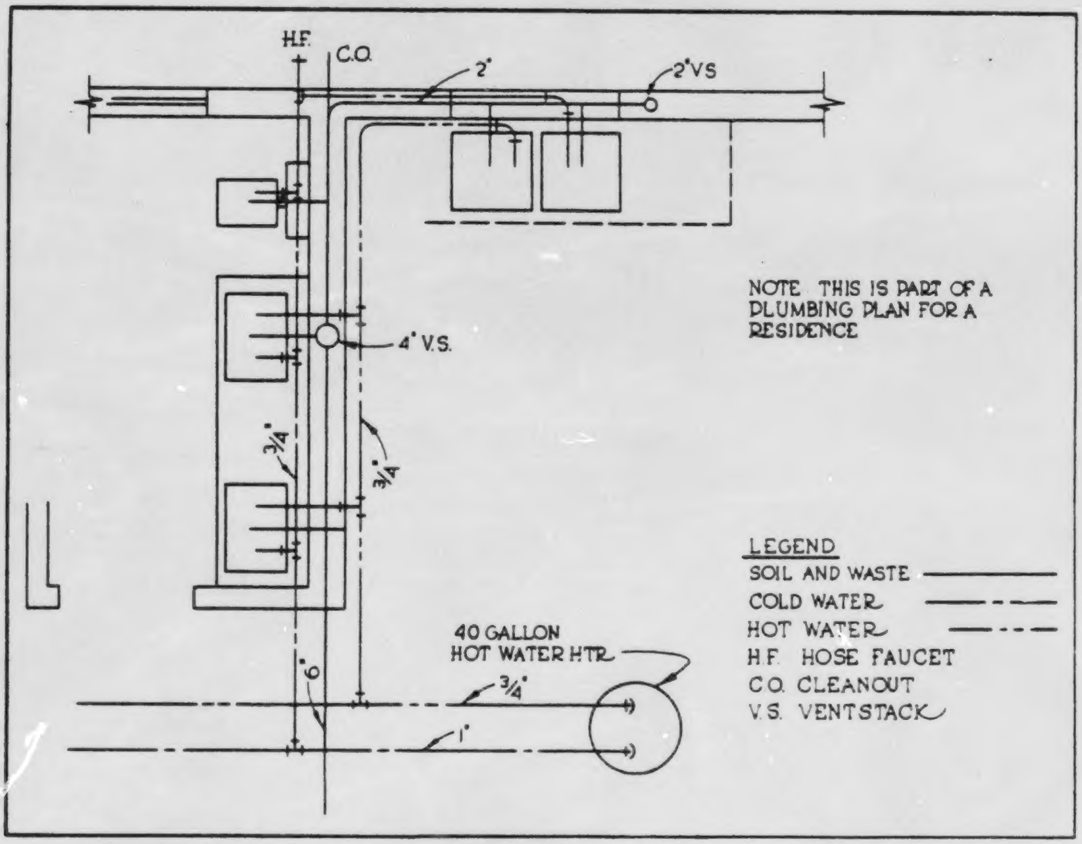


Figure 21. Plumbing plan.

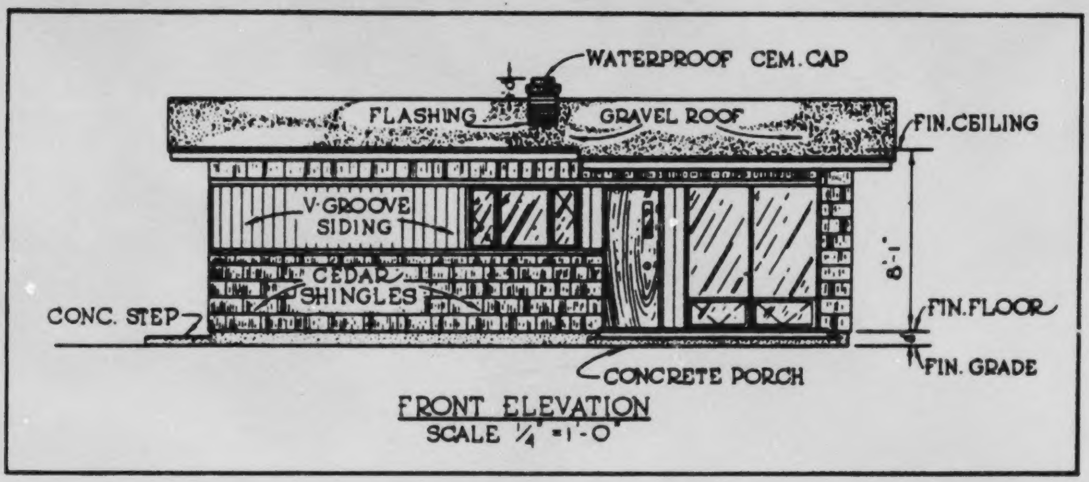

WATERPROOF CEM. CAP
FLASHING
GRAVEL ROOF
FIN. CEILING
V-GROOVE SIDING
CEDAR SHINGLES
8'-1"
CONC. STEP
FIN. FLOOR
FIN. GRADE
CONCRETE PORCH
FRONT ELEVATION
SCALE 1/4" = 1'-0"

Figure 22.

ing lines are too near each other to place a dimension line between them, two dimension lines are placed outside the working lines with the arrows pointing toward each other and the numerals placed outside one of the dimension lines.

5-27. *Break lines.* Two types of break lines are used. One kind indicates short breaks and the other indicates long breaks. The short break line is drawn freehand. A ruled line with occasional freehand zigzags is used for long breaks.

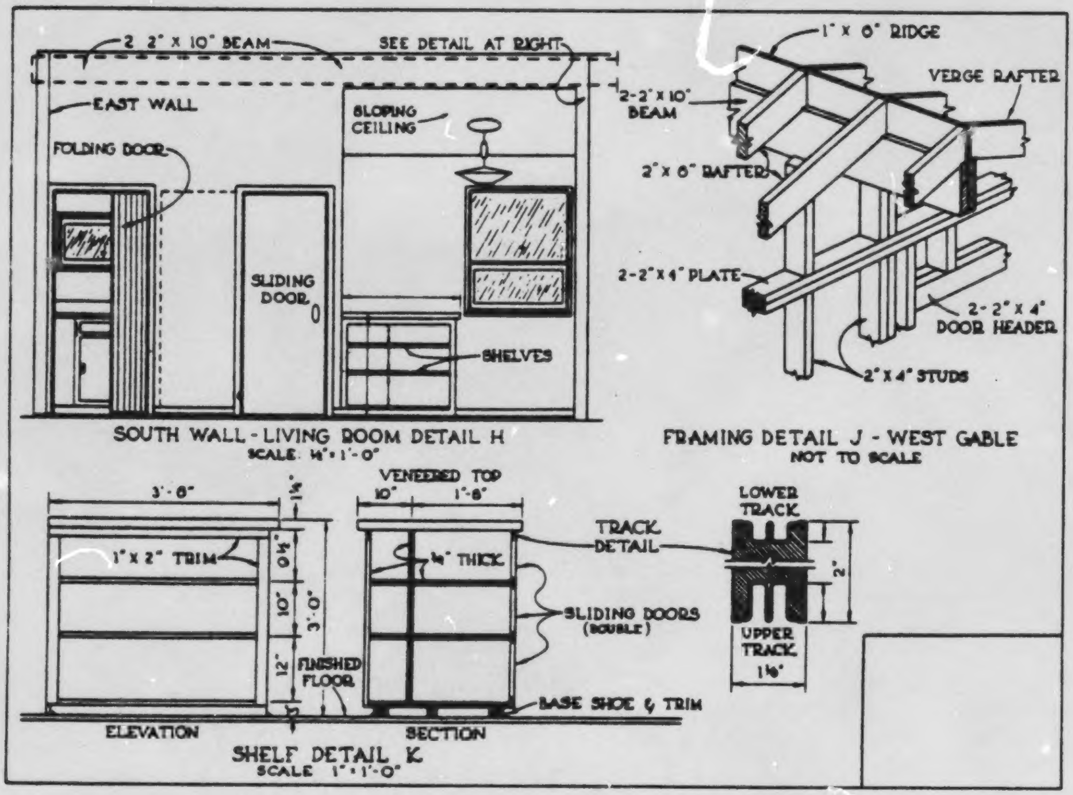

2 2" x 10" BEAM
SEE DETAIL AT RIGHT
EAST WALL
SLOPING CEILING
FOLDING DOOR
SLIDING DOOR
SHELVES
SOUTH WALL - LIVING ROOM DETAIL H
SCALE 1/4" = 1'-0"
1" x 6" RIDGE
VERGE RAFTER
2-2" x 10" BEAM
2" x 6" RAFTER
2-2" x 4" PLATE
2-2" x 4" DOOR HEADER
2" x 4" STUDS
FRAMING DETAIL J - WEST GABLE
NOT TO SCALE
3'-6"
1 1/4"
1" x 2" TRIM
VENEERED TOP
10"
1'-6"
3/4" THICK
TRACK DETAIL
LOWER TRACK
UPPER TRACK
2"
1 1/2"
SLIDING DOORS (DOUBLE)
10"
3'-0"
12"
FINISHED FLOOR
BASE SHOE & TRIM
ELEVATION
SECTION
SHELF DETAIL K
SCALE 1" = 1'-0"

Figure 23. Details.

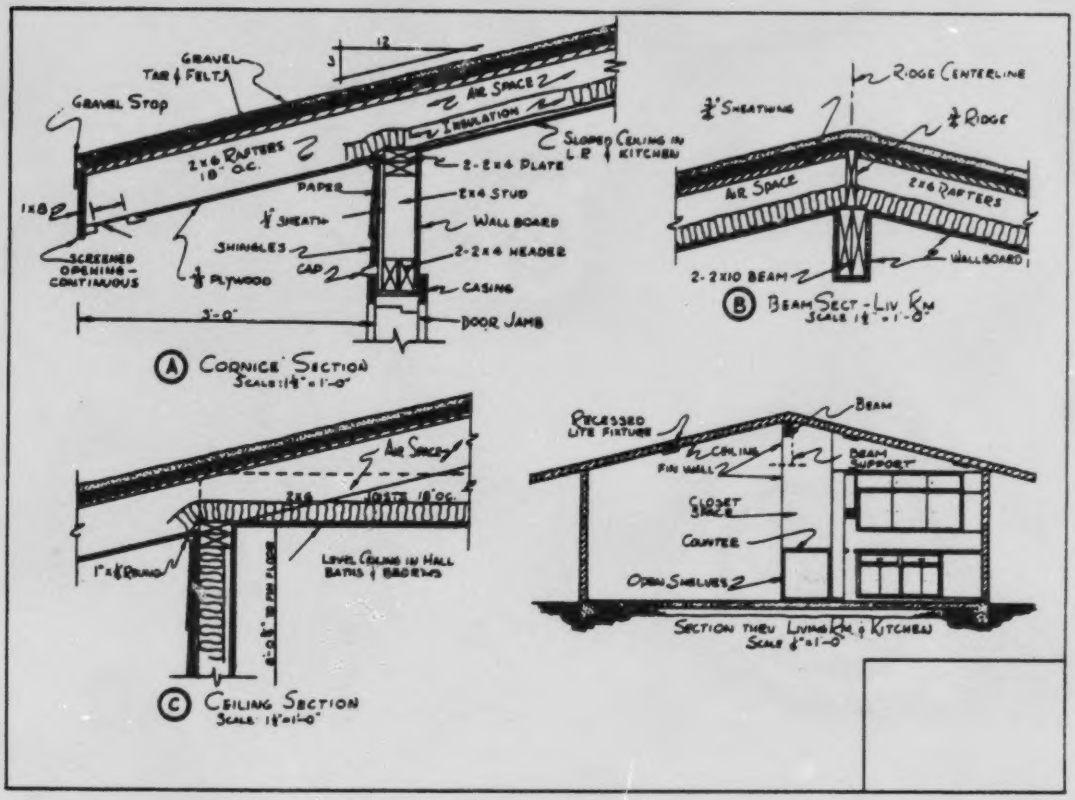

Gravel
Tar & Felts
Gravel Stop
12
3
Air Space
Insulation
2x6 Rafters 18" O.C.
Sloped Ceiling in L R & Kitchen
2-2x4 Plate
Paper
2x4 Stud
1x8
1/2" Sheath
Wall Board
Shingles
2-2x4 Header
Screened Opening - Continuous
1/2 Plywood
Cap
Casing
5'-0"
Door Jamb
(A) Cornice Section
Scale: 1 1/2" = 1'-0"
Ridge Centerline
3/4" Sheathing
3/4 Ridge
Air Space
2x6 Rafters
Wallboard
2-2x10 Beam
(B) Beam Sect - Liv Rm
Scale 1 1/2" = 1'-0"
Air Space
2x6
Joists 18" O.C.
1" x 1/2 Round
Level Ceiling in Hall Baths & Bedrms
8'-0 1/2" to Fin Floor
(C) Ceiling Section
Scale 1 1/2" = 1'-0"
Recessed Lite Fixture
Beam
Ceiling
Fin Wall
Beam Support
Closet Space
Counter
Open Shelves
Section thru Living Rm & Kitchen
Scale 1/4" = 1'-0"

Figure 24. Sections.

Break lines indicate that an object continues without change in detail. Only a short portion of the entire object is represented when break lines are used.

5-28. **Symbols and Terms.** Architectural symbols and terms are used to simplify the drawing. In order to read and understand blueprints, you must be able to recognize and interpret these symbols and terms. Some of the more common symbols are shown in figures 26, 27, and 28. See how many of them look like what they represent. Now read through the list of terms and definitions below.

BASEBOARD—A board placed around a room at floor level to form a finish between the floor and walls.

BASE SHOE—A molding placed around a room at floor level to form a finish between the floor and baseboard.

BEAM—A horizontal wood, steel, or concrete member used to provide support.

CANOPY—A projection over windows, doors, or porches to afford protection against weather.

CASEMENT—A window in which the sash opens upon hinges.

CASING—The wood trim on the vertical sides and top of an opening in a plastered wall.

CHAMFER—A beveled surface cut upon the corner of a piece of wood.

CORNICE—The horizontal molding around the top of a building just below the eaves.

DEADENING FELT—An asphalt impregnated felt used for waterproofing and weatherproofing buildings.

DORMER—A vertical window in a small gable rising from a sloping roof.

DRIP CAP—The projection above the exterior of a window or door to allow water to drain.

EAVES—The portion of the rafters which project from the lower edge of the roof.

FLASHING—Strips of sheet metal or composition roofing material used to waterproof roof intersections and other exposed places on the outside of the house.

FOOTING—The enlarged portion of concrete located in the bottom of foundation walls to spread the load and prevent settling.

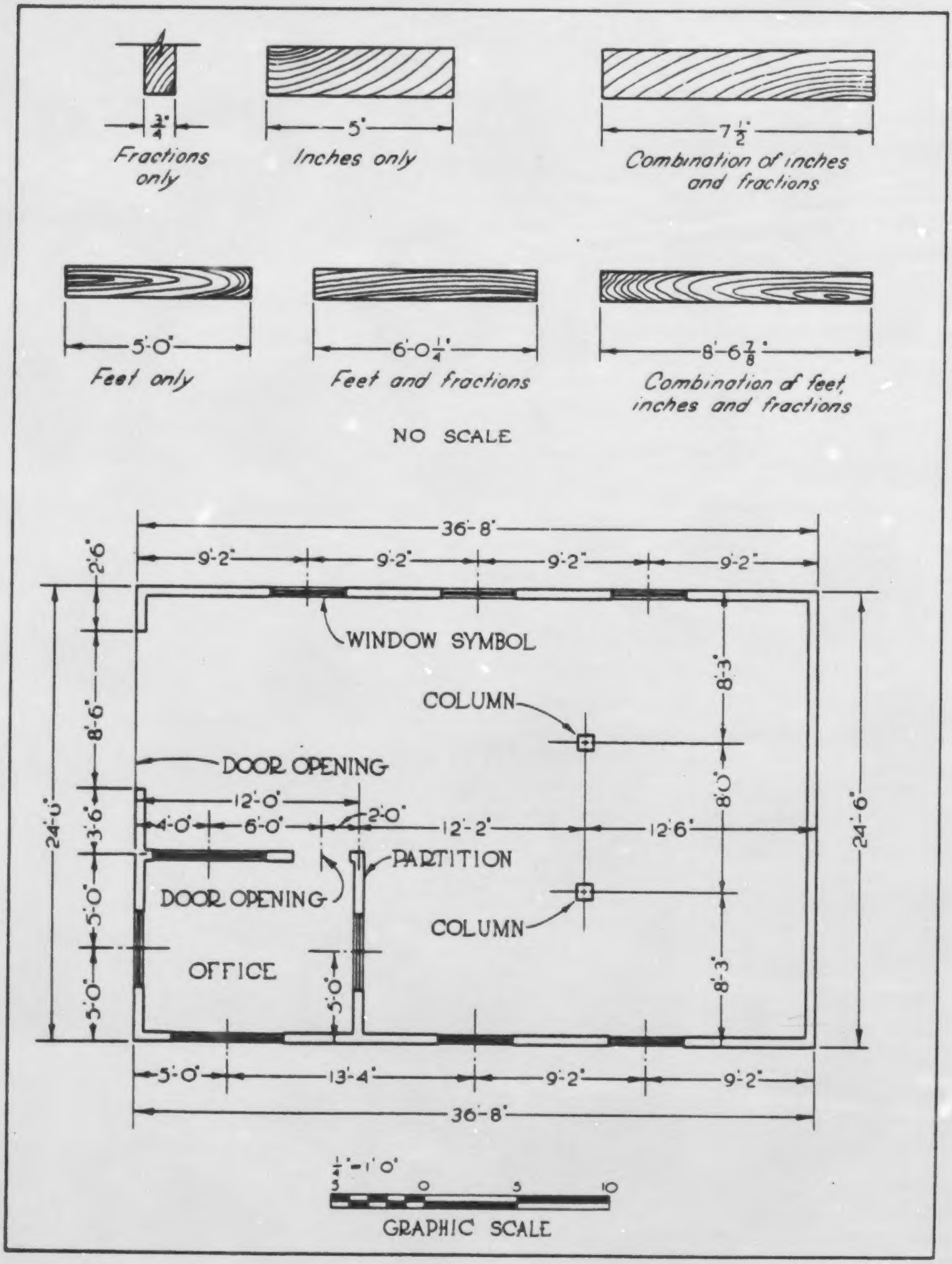

3/4"
Fractions only
5"
Inches only
7 1/2"
Combination of inches and fractions
5'-0"
Feet only
6'-0 1/4"
Feet and fractions
8'-6 7/8"
Combination of feet, inches and fractions
NO SCALE
36'-8"
9'-2"
9'-2"
9'-2"
9'-2"
2'-6"
WINDOW SYMBOL
COLUMN
8'-3"
8'-6"
DOOR OPENING
12'-0"
4'-0"
6'-0"
2'-0"
12'-2"
12'-6"
8'-0"
24'-0"
3'-6"
24'-6"
PARTITION
DOOR OPENING
COLUMN
5'-0"
OFFICE
5'-0"
5'-0"
8'-3"
5'-0"
13'-4"
9'-2"
9'-2"
36'-8"
1/4"=1'0"
5
0
5
10
GRAPHIC SCALE

Figure 25. Dimensioning.

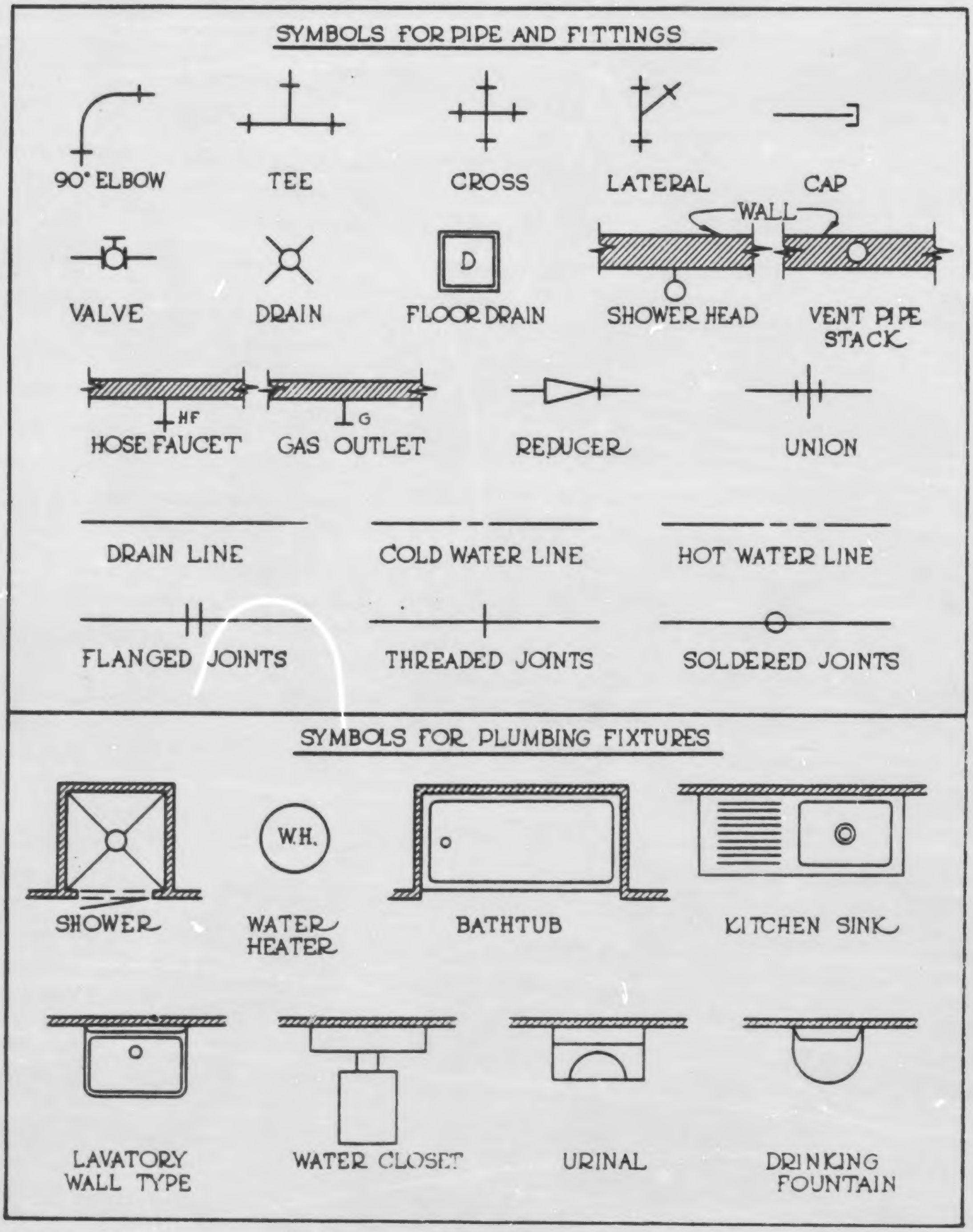

SYMBOLS FOR PIPE AND FITTINGS
90° ELBOW
TEE
CROSS
LATERAL
CAP
WALL
VALVE
DRAIN
D
FLOOR DRAIN
SHOWER HEAD
VENT PIPE STACK
HF
HOSE FAUCET
G
GAS OUTLET
REDUCER
UNION
DRAIN LINE
COLD WATER LINE
HOT WATER LINE
FLANGED JOINTS
THREADED JOINTS
SOLDERED JOINTS
SYMBOLS FOR PLUMBING FIXTURES
SHOWER
W.H.
WATER HEATER
BATHTUB
KITCHEN SINK
LAVATORY WALL TYPE
WATER CLOSET
URINAL
DRINKING FOUNTAIN

Figure 26 Plumbing symbols

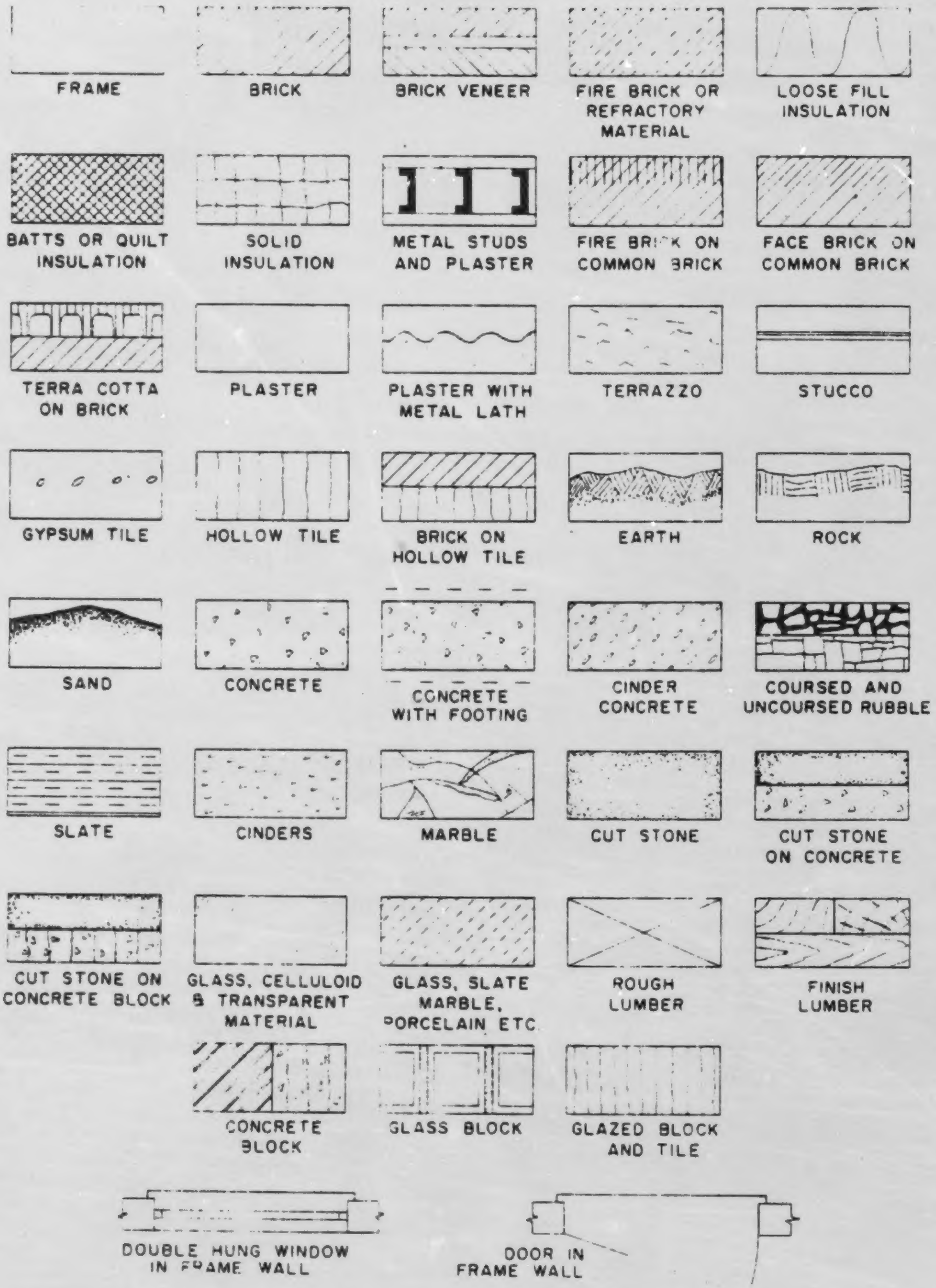

FRAME
BRICK
BRICK VENEER
FIRE BRICK OR REFRACTORY MATERIAL
LOOSE FILL INSULATION
BATTS OR QUILT INSULATION
SOLID INSULATION
METAL STUDS AND PLASTER
FIRE BRICK ON COMMON BRICK
FACE BRICK ON COMMON BRICK
TERRA COTTA ON BRICK
PLASTER
PLASTER WITH METAL LATH
TERRAZZO
STUCCO
GYPSUM TILE
HOLLOW TILE
BRICK ON HOLLOW TILE
EARTH
ROCK
SAND
CONCRETE
CONCRETE WITH FOOTING
CINDER CONCRETE
COURSED AND UNCOURSED RUBBLE
SLATE
CINDERS
MARBLE
CUT STONE
CUT STONE ON CONCRETE
CUT STONE ON CONCRETE BLOCK
GLASS, CELLULOID & TRANSPARENT MATERIAL
GLASS, SLATE MARBLE, PORCELAIN ETC
ROUGH LUMBER
FINISH LUMBER
CONCRETE BLOCK
GLASS BLOCK
GLAZED BLOCK AND TILE
DOUBLE HUNG WINDOW IN FRAME WALL
DOOR IN FRAME WALL

Figure 27. Materials symbols.

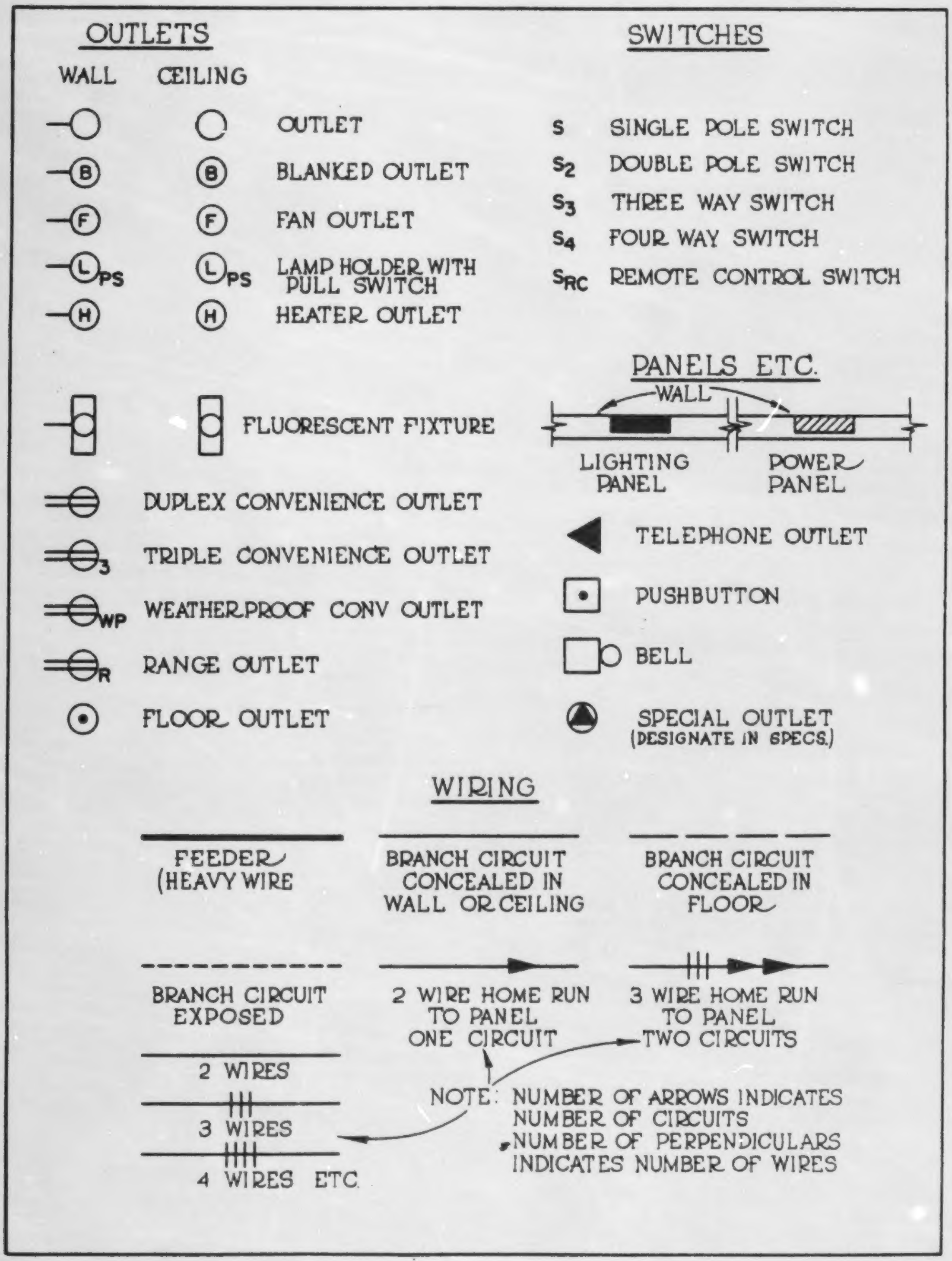

OUTLETS
WALL
CEILING
OUTLET
BLANKED OUTLET
FAN OUTLET
LAMP HOLDER WITH PULL SWITCH
HEATER OUTLET
FLUORESCENT FIXTURE
DUPLEX CONVENIENCE OUTLET
TRIPLE CONVENIENCE OUTLET
WEATHERPROOF CONV OUTLET
RANGE OUTLET
FLOOR OUTLET
SWITCHES
S SINGLE POLE SWITCH
S2 DOUBLE POLE SWITCH
S3 THREE WAY SWITCH
S4 FOUR WAY SWITCH
SRC REMOTE CONTROL SWITCH
PANELS ETC.
WALL
LIGHTING PANEL
POWER PANEL
TELEPHONE OUTLET
PUSHBUTTON
BELL
SPECIAL OUTLET (DESIGNATE IN SPECS.)
WIRING
FEEDER (HEAVY WIRE
BRANCH CIRCUIT CONCEALED IN WALL OR CEILING
BRANCH CIRCUIT CONCEALED IN FLOOR
BRANCH CIRCUIT EXPOSED
2 WIRE HOME RUN TO PANEL ONE CIRCUIT
3 WIRE HOME RUN TO PANEL TWO CIRCUITS
2 WIRES
3 WIRES
4 WIRES ETC.
NOTE: NUMBER OF ARROWS INDICATES NUMBER OF CIRCUITS
NUMBER OF PERPENDICULARS INDICATES NUMBER OF WIRES

Figure 28. Electrical symbols.

GLAZING—The process of installing glass in window sashes.

HEADER—A short joist supporting tail beams and framed between trimming joists; the piece of stud or finish over an opening; or a lintel.

JAMB—The side pieces of a finished door or window opening.

KNEE WALL—The sloping portion of an interior wall which joins the vertical wall and ceiling—used where the wall is less than full room height because it meets the slope of the roof.

LATHS—Narrow strips to support plaster.

LATTICE—Crossed or interlaced wood, iron strips, or bars.

MULLION—The construction between the openings of two windows.

MUNTIN—The small, wooden dividing strips which separate panes or lights of windows.

PURLIN—A timber supporting several rafters at one or more points.

RIDGE—The highest point of a roof.

SASH—The framework which holds the glass in a window.

SHAKES—Hand or machine split sheets of wood used as waterproof siding for exteriors, especially side walls.

SLEEPER—A timber laid on or near the ground to support a floor joist; also strips of wood, usually 2 x 2 laid over a rough concrete floor, to which the finished wood floor is nailed.

WATER TABLE—The finish at the bottom of a building for carrying the water away from the foundation.

5-29. **Common Abbreviations.** Because of the lack of space on blueprints, it is common practice to use abbreviations for many items. Some of the more common abbreviated items are listed below:

Apt. — Apartment
Bm. — Beam
Bldg. — Building
B.R. — Bedroom
C.A. — Cold Air
Clg. — Ceiling
Clos., Cl., or C. — Closet
Cem. — Cement
Conc. — Concrete
Det. — Detail
Diam. — Diameter
D.R. — Dining Room
Dr. — Door
D.S.G. — Double Strength Glass
D.H. — Double Hung
Dn. — Down
Drgs. — Drawings
Ea. — Each
El. — Elevation
Ent. — Entrance
Ext. — Exterior
Fin. — Finish
Flash. — Flashing
Fl. — Flooring or Flush
Fur. — Furring
Gar. — Garage
Galv. — Galvanized
G.I. — Galvanized Iron
Gl. — Glass
H. — Hall
Ht. — Height
H.A. — Hot Air
Jb. — Jamb
K. or Kt. — Kitchen
Lt. — Light
Linol. — Linoleum
L.R. — Living Room
Mldg. — Molding
Mull. — Mullion
Mor. — Mortar
O.C. — On Center
O.S. — Outside
O.S. Cas — Outside Casing
R. — Riser or Radius
Rm. — Room
Sec. — Section
Specs. — Specifications
S.S.G. — Single Strength Glass
Wd. — Wood
Yd. — Yard

5-30. **Specifications.** In the preceding paragraphs you learned the types of working drawings and how to read them. These drawings and prints would be worthless without the written notes and specifications explaining the types of materials and different aspects of the job. So you can see the importance of construction notes and specifications.

5-31. The written notes and explanations about materials or other items that appear on a drawing are called specifications. It is necessary to have these written notes in order to give complete information. For example, a symbol on a drawing may show that a building is to have wood siding. The carpenter must know how much of the siding is to be exposed to the weather. This information is given as a note on the drawing.

5-32. In addition to the notes on the drawing, a written set of specifications is included as a part of every complete set of plans or prints. These specifications are as important as the drawings. They describe all materials and give detailed instructions concerning the building. The specifications must be studied as carefully as the drawings in order to fully understand the plans.

5-33. The specifications are usually made in separate divisions for each of the building trades, such as plumbing, painting, or carpentry. The division pertaining to carpentry will indicate who will furnish and complete all carpentry work shown on the drawings or given in the specifications. This division will contain a list of work included as follows:

- All wood framing, including framing for all trades.
- All woodwork, trim jambs, doors, paneling, plywood, and interior millwork.
- All wood furring, nail strips, sleepers, blocking, grounds, wood bucks, wood studs, etc.
- Rough hardware (nails, spikes, bolts, etc.).
- Finish hardware.
- Cutting and fitting all woodwork in this division for work of all trades.
- All other carpentry work necessary to accomplish the particular job.

5-34. Each division of the specifications will contain specific information about the materials to be used on the job. The material section of the carpentry division gives all information related to materials and methods of installation as listed below:

- The exact grade, species, size, and moisture content of wood to be used for various parts of the building.
- The spacing of various members, such as studs, rafters, joists, etc.
- The placing of studs, trimmers, or headers around all openings.
- The type of wood to be used for interior finish when this information is not indicated on the drawings.
- The erection of all members plumb, level, square, and true in accord with details.
- The use of fastening devices, such as nails, bolts, screws, toggles, etc.
- All other information necessary to assure that the materials used are of a certain standard and the quality of workmanship is acceptable.

5-35. In addition to the other information included in the specifications, a complete description of the building site should be included. A drawing showing how the building is to be placed on the specified plot of ground should be included in the plans.

5-36. **Sketching.** If instructions for a complete job were given you in the form of a complete written or oral description of detail units, they would probably confuse you and the workmen under you. It is a more efficient practice to present the job you are required to do in the form of a freehand drawing or sketch. It can show several views so that details of construction or repair may be readily interpreted. Dimensions and notes on a drawing or sketch make it simple for you to interpret and give you clear concise information to guide you or your workmen in doing the job. When you plan the work to be done, or when you translate someone's oral instructions, you will need to make your own sketch. Draw whatever views you need to make clear the work needed. The quality of the sketch is unimportant. However, it must show the shape and position of the pieces and be marked with the exact dimensions.

5-37. Whether you use sketches or drawings that have been mechanically duplicated, some form of picture is necessary in nearly all of your construction or repair work. Your drawing must also include notes and specifications. With your sketch or drawing, notes, and specifications, you will be able to plan your work. You can decide what work should be done first and schedule the arrival of materials and hardware on the job site. You would not want materials for interior finish delivered before or with the foundation and framing materials.

6. Bill of Materials

6-1. When you are to do jobs other than prefabricated buildings, you will, after some supervised practice, prepare your bill of materials. The master packing list for a prefabricated building is a bill of materials; but, like the materials themselves, it comes with the complete package.

6-2. Before any woodworking project can be started, a complete list of materials should be made. This is done by studying the plans and specifications and preparing an itemized list of everything required. This list, called a bill of materials, shows quantity, size, and purpose for each item needed to complete the job. To prepare the list, you must first learn to figure board feet of lumber and to identify the most desirable hardware for the job. You must know the types and sizes of nails, screws, hinges, and all the other items for a complete job.

6-3. Before making a final bill of materials, it is a good idea to make out a temporary bill. This temporary bill should show the number of pieces, the size of each piece, and for what each is to be used. From this temporary bill, a final bill of materials can be made by grouping all like items together. Prices may be included if an estimate of cost is required.

6-4. **Preparing a Bill of Materials.** When preparing a temporary bill of materials, follow the building sequence. On most frame buildings, the first pieces of lumber used for construction are the sills. The next items will probably be the floor joists, subflooring, sole plates, and studs. The listing may change with various types of construction, but it shouldn't make any difference if every item of material is listed.

QUANTITY	UNIT	SIZE	BD. FT.	USE	COST
2	Pc.	4" x 4" x 7'-0"	19	Girder Posts	This column will be used only when estimating cost. (Current prices should always be used.)
1	Pc.	2" x 8" x 16'-0"	22	Girder	
10	Pc.	2" x 8" x 14'-0"	187	Girder, Joists	
2	Pc.	2" x 8" x 12'-0"	32	Joist Header	
47	Pc.	2" x 8" x 10'-0"	627	Girder, Joist Header, Joists	
2	Pc.	2" x 8" x 8'-0"	22	Joist Header	
2	Pc.	2" x 6" x 12'-0"	24	Sills	
2	Pc.	2" x 6" x 10'-0"	20	Sills	
2	Pc.	2" x 6" x 8'-0"	16	Sills	
6	Pc.	2" x 4" x 16'-0"	64	Plates	
11	Pc.	2" x 4" x 14'-0"	103	Plates	
18	Pc.	2" x 4" x 10'-0"	120	Plates	
123	Pc.	2" x 4" x 8'-0"	630	Studs	
90	Pc.	1" x 12" x 12'-0"	1080	Sub-flooring, Sheathing	
36	Pc.	1" x 12" x 10'-0"	360	Sub-flooring, Sheathing	
20	Pc.	1" x 12" x 10'-0"	200	Sub-floor	
11	Pc.	1" x 4" x 12'-0"			

Figure 29. Bill of materials.

6-5. The consolidated, or final, bill of materials usually has the largest and longest pieces listed in sequence down to the smallest and shortest. This is illustrated in figure 29. Notice the similarity of this list to the packing list of the prefabricated buildings.

6-6. *Estimating lumber.* When figuring the amount of lumber, allowances must be made because surfaced and edged boards never measure full size. And there is always some waste due to odd lengths.

6-7. A good rule to follow, when estimating flooring, siding, tongued-and-grooved lumber, and other similar shaped or lapping materials, is to make a fraction using "1" over the width of the material in inches and add that fractional part to the total. As an example, add 1/6 for 6-inch material, ⅛ for 8-inch material, etc. Let's work out an estimation for flooring needed to cover a room 8 feet wide and 12 feet long. The flooring will be 1″ x 8″ x 12′ material. To find the number of board feet or boards required to do the job, first convert the width of the room into inches (8″ × 12″ = 96″). Although you can use either figure to do this, we have chosen the width. Next, divide the width of the flooring unit (8″) into the width of the room in inches (96″), which equals 12, the number of boards theoretically required to cover the room. However, this is not true, because we have not considered our necessary waste allowance. To do this, we must find the number of board feet in one of our 1″ x 8″ x 12′ flooring boards. You will learn how to figure board feet in paragraph 6-9. For this problem, we have already figured the board feet, and there are 8 board feet in one board. You are now ready to continue with the estimation. Next, take the number of board feet in the board (8) multiplied by the number of boards required (12), which equals 96, the number of board feet. Now, take ⅛ of the total (96) and add 12 to the total (96), which equals the number of estimated board feet (108) required to do the job. If you want the number of boards required to do the job, you take the number of board feet in one board (8) and divide into the number of board feet required (108), which equals the number of boards (13½ changed to 14) required for the job. This rule will not work for S4S (surfaced 4 sides) or common lumber. For estimating when using the S4S lumber, you will allow an extra 10 percent for your waste allowance.

6-8. *Estimating cost.* After the bill of materials has been completed, figure the cost of each individual item and compile an overall total. After this total has been determined, add another 10 percent. This 10 percent allows for small items that might have been overlooked, price changes, and small margins of error. This figure is for the cost of materials. In addition to the cost of materials, you must figure an estimated cost of the labor connected with the job. To estimate the time needed for a task, you need an established standard performance time set for each particular task in the carpentry area. You will find such a set standard in TM's on Maintenance Management for Real Property Facilities. It gives the standard performance data for each individual task performed. This standard performance time is used in your estimation of man-hours or labor for the job. Let's take the task of installing sheetrock in a newly constructed building. The manual sets the standard man-hours for this task at 10 square feet per 2/10 hour, or 12 minutes. For a sheet of 4 x 8 sheetrock, which contains 32 square feet, 38.4 minutes will be needed for the installation. For 10 sheets, it will take 384 minutes, or 6 hours and 24 minutes, which would be your estimated time for the installation. The estimated time is multiplied by the average hourly rate of the men doing the complete job, to arrive at the estimated labor cost for the job. Total the estimated cost of the building materials with the total cost of all of the estimated labor involved to get the total estimated cost of the complete job.

6-9. *Units of measure for lumber.* All lumber is figured on a basis of board feet, square feet, or linear feet. The terms "board feet" and "square feet" are used extensively throughout the lumber industry. A board foot of lumber is a piece 1 foot long, 1 foot wide, and 1 inch thick. The board foot should be used when computing the cost of lumber. To determine the number of board feet in a piece of lumber, multiply the length in feet by the width in feet by the thickness in inches. As an example, if you had a board 6 feet long, 8 inches wide, and 1 inch thick, you would compute as follows: $6/1 \times 8/12 \times 1/1 = 6/1 \times 2/3 \times 1/1 = 12/3 = 4$ board feet. The 8/12, of course, represents 8 inches stated as 8/12 foot.

6-10. A square foot of lumber is a piece 1 foot long, 1 foot wide, and any thickness less than 1 inch. To figure square feet, we are concerned only with the length and width. Therefore, the thickness must be less than 1 inch. If the thickness is 1 inch or greater, the computation must be made in board feet.

6-11. Lumber is purchased by the piece, linear foot, square foot, board foot, or bundle. Order lumber by the piece if all are to be the same length or a definite length is needed to cut without waste. Order by the linear foot if the stock is to be cut into several lengths or can be joined anywhere. Order by the board foot if an area is to be covered with lumber 1 inch or thicker. Order by the square foot if the area to be covered is the only concern, that is, if the thickness is of no consequence. Order by the bundle when material can be purchased only by the bundle.

6-12. **Building Hardware.** The term "hardware" is used to identify the metal items used by the woodworker. Two general classes of hardware are rough and finish hardware. Some of these items are used in both building construc-

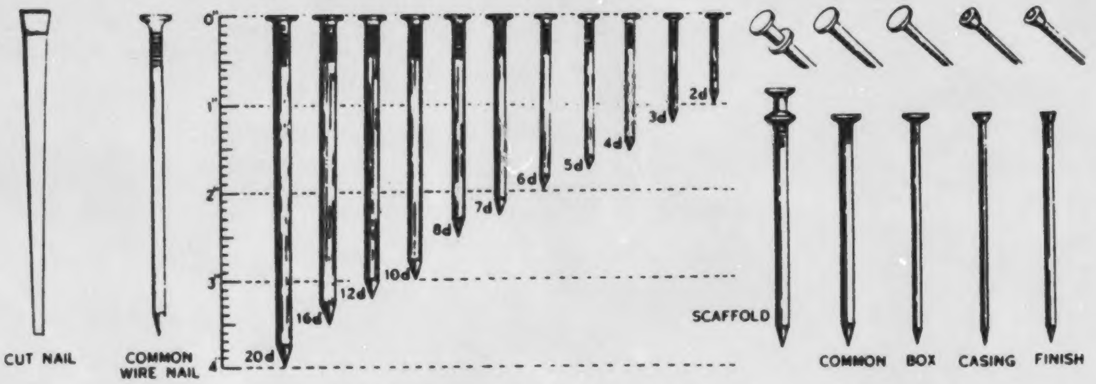


Figure 30. Types and sizes of nails.

tion and furniture construction. The items used in building construction will be discussed here.

6-13. In building construction, the *rough hardware* is usually the metal items used where extra strength is required. This group consists of a large number of items generally made of iron or steel with no particular ornamental finish on the metal. Rough hardware may be concealed within the walls of a structure or exposed to provide security on temporary constructions. Rough hardware is not used for decorative purposes and generally does not add to the appearance of the building.

6-14. Hardware items used for ornamental purposes, such as hinges, drawer pulls, or other miscellaneous items, are classed as *finish hardware*.

6-15. *Nails.* Two general kinds of nails are used by the woodworker. They are cut nails and wire nails, as illustrated in figure 30. Cut nails are made by machine from steel plate. They are wedge shaped, with a head on the large end, and are often used to nail flooring because they are very hard steel and have good holding power.

6-16. Wire nails are formed by machine from standard sized wire. The wire is fed into the machine from a roll; it is straightened, the point is cut, and the head is formed all in one operation. Wire nails are divided into five main types—common, box, finishing, casing, and scaffold.

6-17. Nail sizes are given by a penny or pound number from twopenny to sixpenny. This number was originally the weight of one thousand nails. A small letter "d" is usually used to abbreviate "penny." The penny number now refers to the length of the nail instead of its weight. The nail chart in figure 30 shows the length of nails from 2d to 20d. Nails are usually packaged in 100-pound wooden kegs. Smaller quantities, however, may be purchased. Figure 30 illustrates the five common types.

6-18. *a. Common nails*—Common wire nails have a fairly thick flat head. They are generally used for most phases of building construction. The wire from which they are made is large enough for easy driving without bending.

6-19. *b. Box nails*—Box nails are used in box construction or wherever there is a possibility of splitting the wood with a common nail. These nails are easier to bend while driving because of the smaller diameter wire used to form them. The head of a box nail is somewhat thinner and larger in diameter than the head of a common nail. Box nails are sometimes coated with a special cement to give them better holding qualities and make them harder to pull. These are called cement-coated box nails or "sticky" nails.

6-20. *c. Finishing nails*—Finishing nails and box nails are made of the same diameter wire. The head of a finishing nail is only slightly larger in diameter than the body of the nail so that it can be embedded (set) into the surface of the wood. There is a slight depression on the top of the head to help prevent the nail set from slipping off the head. The small hole that is made in the wood is filled with glazier's putty or some other filling agent to hide the nail when the surface is finished.

6-21. *d. Casing nails*—The casing nail is similar to the finishing nail in appearance. The head, however, is slightly larger and has no depression in the top. These nails are used to nail door and window casings in place.

6-22. *e. Scaffold nails*—The scaffold nail is the same diameter as the common nail, the difference being the double head provided on the scaffold nail. These nails are used on scaffolds, forms, or wherever the construction is temporary and it is necessary to remove the nails after a short time. The first (bottom) head draws the board and has a good binding effect, while the second (top) head sticks out so that it can be used for pulling the nail.

6-23. *f. Rustproof nails*—Nails must sometimes be used where the head is exposed to the weather. The head often rusts and causes a black streak along the grain of the wood, even though it is painted. It is desirable then to use a nail that will not rust. Plain wire nails that have a zinc coating are often used where there is a possibility of rusting. These are called galvanized nails. The zinc is sometimes cracked or chipped off the body of the nail and allows the nail to rust. They are probably the most commonly used rustproof nail, because they are only slightly more expensive than ordinary nails. There are other nails made of solid copper or aluminum which are absolutely rustproof. They are, however, more expensive than galvanized or copper coated nails.

6-24. *Screws.* Wood screws are made of iron, bronze, brass, copper, or other metals. They are sometimes plated with nickel or chrome to match special finish hardware. Wood screws have some advantages over nails, but they also have disadvantages. A few of the advantages are that they will hold the wood more securely than nails, they are easily tightened and removed, and the heads are neat in appearance and are often left exposed on finished surfaces. Some of the disadvantages are that they are more expensive than nails and require more care and labor to drive them. Wood screws are made with heads of various shapes, either flat, oval, or round, as shown in figure 31. They may have different-sized shanks and a great variety of lengths. The shank of the screw is the smooth part of the screw between the head and the threads or spiral.

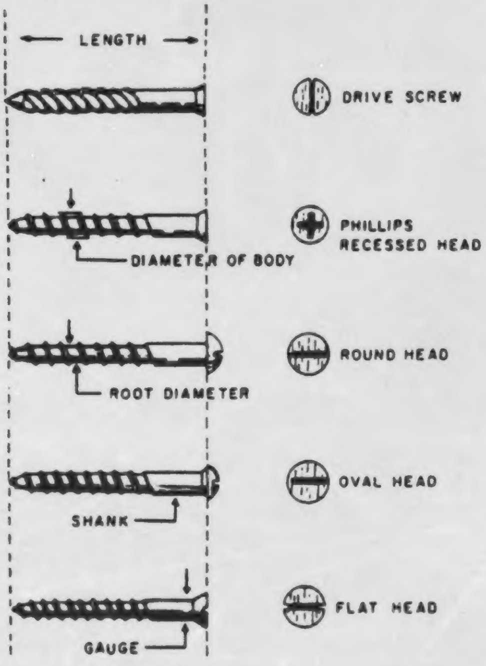


Figure 31. Types of screws.

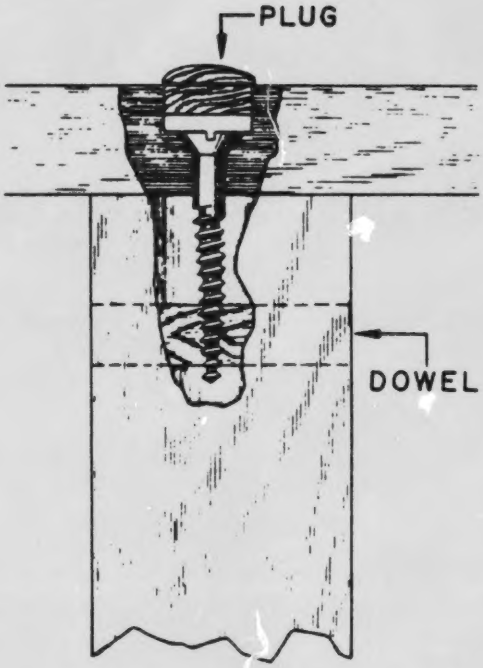


Figure 32. Plugged screw.

6-25. The size of a screw is designated by a gauge number that represents the diameter of the shank of the screw. If the diameter is known, the approximate gauge can be determined by subtracting 1/16 inch from the diameter and multiplying by 80. For example, the diameter of a screw is approximately 3/16". Subtract 1/16" from 3/16" and the result is 1/8". One eighth multiplied by 80 equals 10, so the screw gauge is 10. If the screw gauge is known, the diameter can be determined by dividing it by 80 and adding 1/16. The variation in length of wood screws is about the same as that for nails, except that each gauge of screw is made in several lengths. The length and gauge number must both be given when specifying screws. For example, 1¼" by 10. Screws are packaged in cardboard boxes of 1 gross each; however, they can usually be purchased by the dozen.

6-26. *a. Drive screws*—Special screws that are made to be driven with a hammer are called drive screws. They may have a round head but are usually made with a flat head. They are made with the threads far apart and may have no slot for a screwdriver. Drive screws are available in the same sizes as wood screws, and in addition, they are available in larger sizes with a square head, the same as lag screws.

6-27. *b. Phillips head screws*—These are called Phillips screws, and a special screwdriver is required for driving them. Some advantages of the Phillips screw are that the screwdriver doesn't slip out easily and the head is not as apt to break as that of a conventional type screw.

6-28. *c. Roundhead screws*—The roundhead screw is usually used on a surface where the head will show. The head is not countersunk, and for this reason, it should have a pleasing finish—either blued or polished. The screw slot should always be left in a position parallel to the grain of the wood.

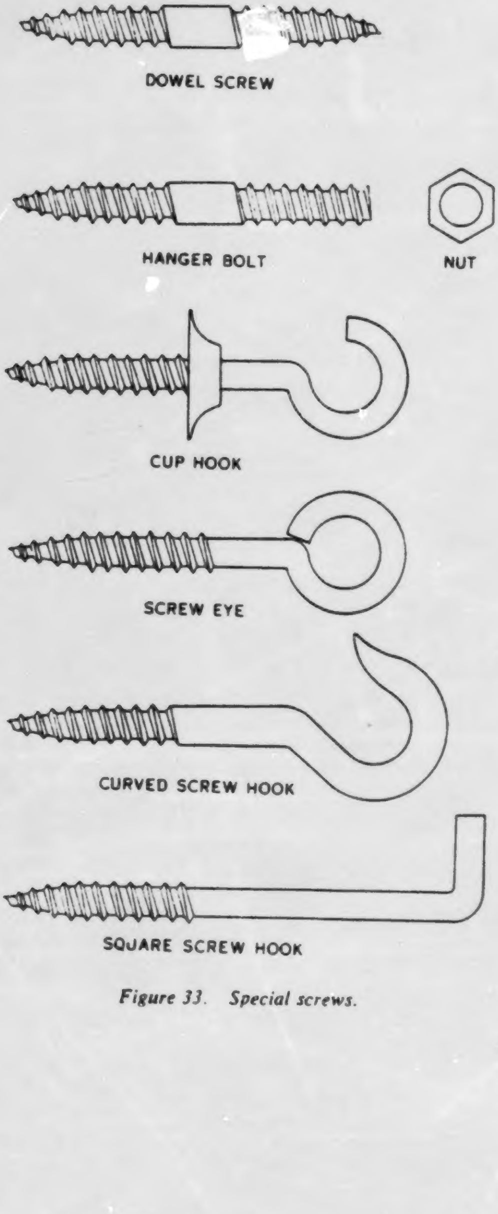


Figure 33. Special screws.

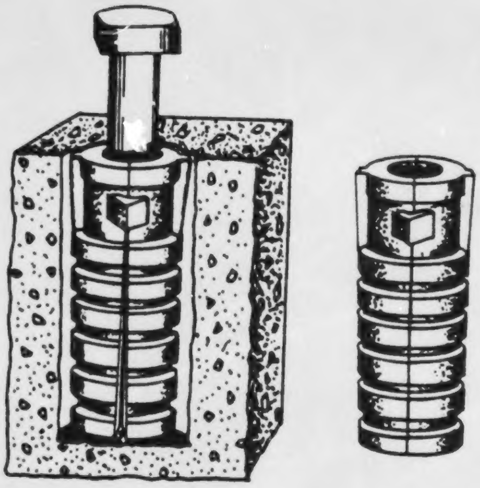


Figure 34. Expansion shields.

6-29. *d. Ovalhead screws*—The ovalhead screw is used to fasten hinges or other finish hardware to wood. The screw slots of all these screws should be parallel to each other for better appearance.

6-30. *e. Flathead screws.* Flathead screws are made to be used where the head will not show. The head should be countersunk until it is level with or slightly below the finished surface. If flathead screws are used on an exposed area, they should be countersunk in a hole that can be plugged, as shown in figure 32.

6-31. *f. Special screws*—Many special hanging and fastening devices having a screw-type body are shown in figure 33. The screw eye is often used on picture frames, screen doors, and many other items. The curved screw hook and right-angled screw hook are mainly used for hanging articles. The curved screw hook is usually used in the ceiling, while the right-angle hook is more often used on vertical walls.

6-32. *g. Expansion shields*—Lag screws are used with expansion shields for anchoring frame construction, machines, or hardware items to concrete that has hardened. A hole is drilled into the concrete the size of the outside diameter of the expansion shield, and the shield is placed in the hole. The shield expands, as shown in figure 34, and holds against the side of the hole as the lag screw is driven into the shield.

6-33. *h. "Molly" universal screw anchors*—"Molly" fasteners are used to provide a solid means of attaching fixtures to interior walls. A hole is drilled the same size as that of the out-

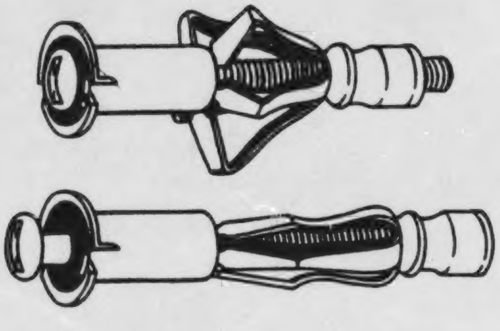


Figure 35. "Molly" fasteners.

side diameter of the fastener. They are designed to expand behind the wall covering, as shown in figure 35, and will stay in place when the bolt is removed.

6-34. ***Bolts.*** Bolts are made of steel with either a round, square, or octagon head and a threaded shank, as shown in figure 36. The threads may run the full length of the bolt; or they may stop a certain distance from the head, leaving a smooth upper shank. Bolts are used to fasten timber, steel, or other materials. They range in diameter from 3/16" to 1½", and in length from ¾" to 30". They are available in three main styles: stove bolts, machine bolts, and carriage bolts. Stove bolts, however, are used mostly with small items of hardware.

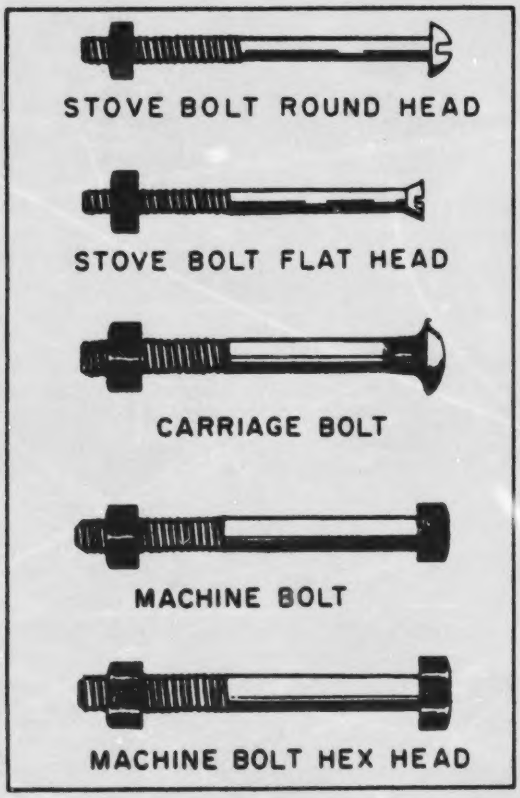


Figure 36. Types of bolts.

6-35. *a. Machine bolts*—The machine bolts used in woodwork usually have square heads and square nuts. A metal washer is generally used under both the head and the nut. These washers prevent the head from embedding into the wood and keep the nut from tearing the wood fibers as it is turned. Two wrenches are required when tightening the machine bolt.

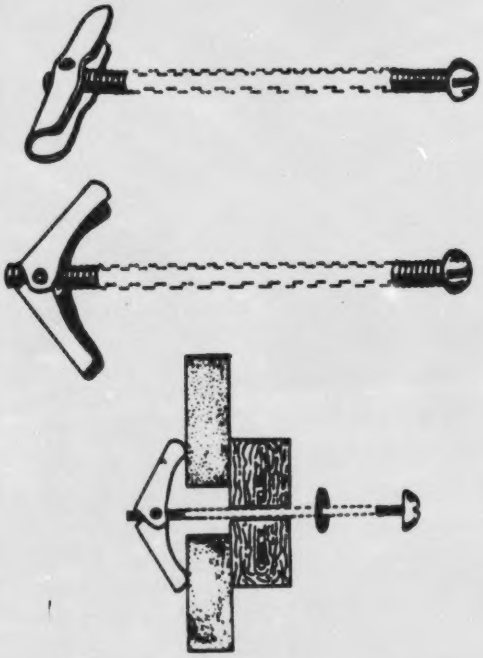


Figure 37. Toggle bolts.

6-36. *b. Carriage bolts*—Carriage bolts are like machine bolts except for the head, which is round. The shank of the carriage bolt has a square portion that draws into the wood and prevents the bolt from turning as the nut is tightened. A washer is used under the nut of the carriage bolt but not under the head.

6-37. *c. Toggle bolts*—Toggle bolts are used to fasten wood stringers or fixtures to masonry walls. There are two common types of toggle bolts: the pivot wing type and the spring wing type. Both types have heads similar to those of ordinary wood screws. You will note in figure 37 that the pivot type has a bent iron channel with the nut slightly off center so that one end of the channel is heavier than the other. A hole is drilled into the plaster wall, going through to the hollow space. The heavy end of the nut drops down at right angles to the bolt when it is inserted into the hole. The nut will pull up tight against the lath and plaster as the bolt is tightened. The spring type is made like the pivot type except that the wing is hinged in the center. It is held open with a small spring and can be closed while inserting it into the hole. It snaps open when it enters the hollow cavity of the wall. Tightening is done in the same manner as with the pivot type. The bolt should not be removed after it has been inserted into the hole because the nut will fall. The spring type works very well on either vertical walls or ceilings. The pivot type, however, is not satisfactory overhead. Both types of toggle bolts are available in various sizes.

6-38. *Hinges.* Many different types, styles, and sizes of hinges are used by the woodworker. They are, however, all used to make a movable joint between two pieces of material. They are made of many different metals for various uses. The most common hinges have two leaves that are cut and formed so that they are held together with a pin. The pin may be removable (loose pin), as shown at the top of figure 38, or it may be riveted on each end to prevent removing it (tight pin). When loose pin hinges are used on a door, the door can be removed by removing the pins. The length and width of the leaves determine the size of the hinge.

6-39 *a. Full mortise*—The leaves of a full mortise hinge are completely hidden, leaving only the barrel exposed when the door is closed. A gain (mortise) is required for each leaf. The gain for one leaf is in the edge of the door and the other gain is in the door frame. The gains make this type of hinge one of the most difficult to install. The full mortise hinge looks very much like the full surface hinges, as shown at the top of figure 38.

6-40. *b. Full surface*—The full surface hinge requires no gain for either leaf. One leaf is screwed to the flat surface of the door and the other leaf is screwed to the frame. The surface of the frame and door must be flush when full surface hinges are used.

6-41. *c. Half surface*—You will note in figure 38 that the half surface butt-type hinge is similar to both of the other hinges. One leaf is fastened on the surface of the door and the other leaf fits into a gain in the frame. The hinges used on passage doors are usually half surface or full mortise butts. The hinges used on fence gates, barn doors, or for other heavy-duty work are generally full surface T-hinges or full surface strap hinges.

6-42 *d. Cabinet hinges*—Cabinet hinges are made in many styles and finishes to provide an adequate selection for every type of cabinet. Either full mortise, full surface, or half surface hinges are used for cabinet work. Figure 38 shows a few of the many designs of cabinet hinges.

6-43. *e. Special hinges*—Many other types of hinges, such as a double-action hinge for a swinging door, a loaded hinge for screen or storm doors, invisible hinges, and continuous hinges, as shown in figure 38, are also available.

6-44. *f. Hinge hasp*—A hinge hasp is made similar to a hinge, but the leaves are made

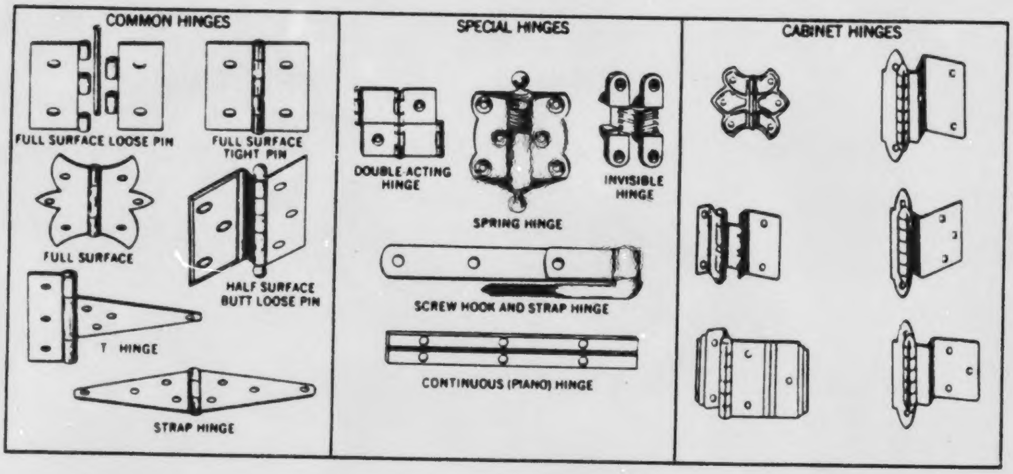


Figure 38. Types of hinges.

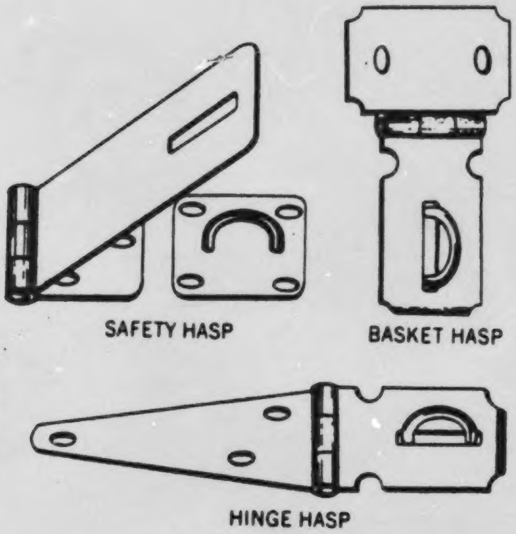


Figure 39. Hinge hasps.

differently. One leaf has screw holes for fastening the hasp in place, the other leaf is longer with a slot cut near the outer end, as shown in figure 39. A heavy metal loop, reveted to a square metal base, is used with the hinge hasp. The base of the loop is fastened in place with four screws. The slot in the long leaf of the hasp fits over the loop. The hasp is used with a padlock as a locking device. The long leaf of the safety hasp covers the heads of all screws when it is in the locked position.

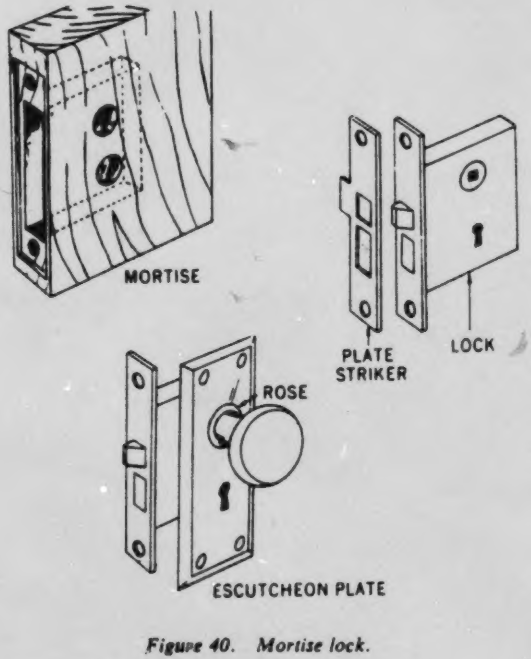


Figure 40. Mortise lock.

6-45. *Locks.* Like hinges, locks are also available in a great variety of styles, sizes, and finishes. The installation and repair of locks are covered in Volume 2 when we discuss the subject of doors. Three types are in general use: mortise locks, rim locks, and tubular locks.

6-45. *a. Mortise type*—Mortise-type locks, as shown in figure 40, are made for many different purposes, but the wood must be cut away when installing any of them. Mortise locks are difficult to install because of the deep mortise that must be made.

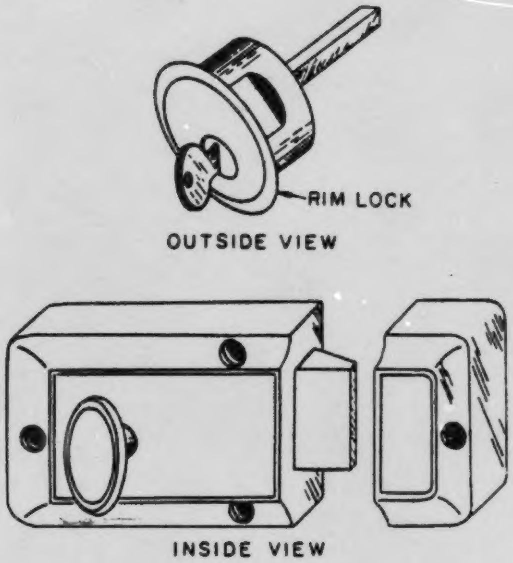


Figure 41. Rim lock.

6-47. *b. Rim type*—Rim locks are easier to install because they are usually applied to the inside surface of exterior doors. One bored hole is usually all that is required. On some types, however, a recess must be cut out for the lock. This type is shown in figure 41.

6-48. *c. Tubular type*—Tabular locks are a relatively new item on the market. They have all the advantages of mortise locks but are much easier to install, since only bored holes are required. Special instructions for installation are included with each type of lock. Study these instructions before attempting to install any of these locks.

6-49. *d. Striker plate*—The striker plate is usually mortised into the frame of the opening for all of the various types of locks. The striker

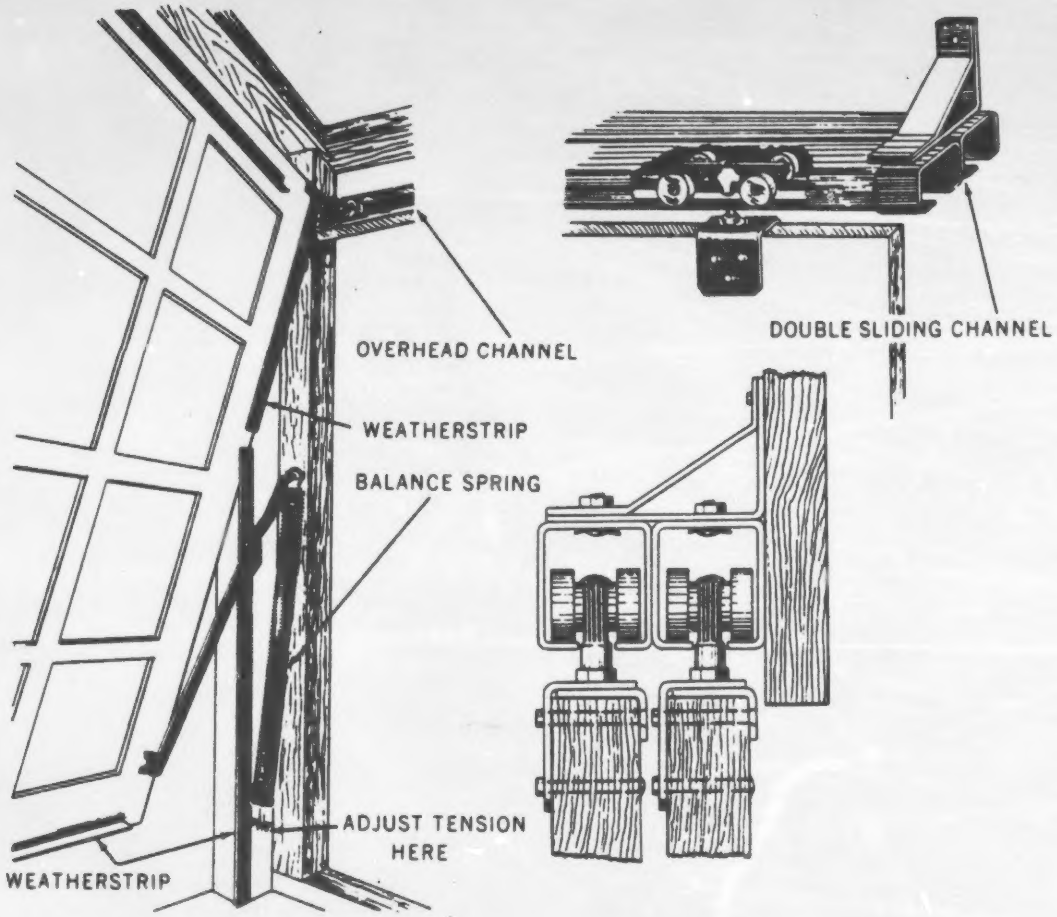


Figure 42. Sliding door track assemblies.

plate prevents the wood from wearing or splitting and cannot be pried loose easily.

6-50. *Sliding door track assemblies.* Heavy doors for airplane hangars, garages, or barns are sometimes mounted on rollers and channels, rather than hinges. This makes them sliding instead of swinging doors and eliminates the possibility of sagging. There are many different types of sliding door assemblies available. They are very small for light closet doors or very large for heavy hangar doors. The type of sliding door assembly will depend on the type of construction and purpose of the building. Figure 42 shows two typical sliding door track assemblies.

6-51. *Cupboard catches and bolts.* Catches and bolts are fasteners that hold a door closed but are not locked with a key. Let's examine a few of the bolts and catches most commonly used in cabinet work.

6-52. *a. Elbow catch*—The elbow catch, as shown in figure 43, is used when the cupboard or bookcase has a double door. The striker plate is fastened to the underside of a shelf. The catch is fastened to the inside surface of the door so that it hooks over the plate when the door is closed. The right-hand door must be opened in order to reach behind the left-hand door and release the elbow catch.

6-53. *b. Ball and friction spring catches*—They are used to hold small doors closed; they snap into place and friction on the catch holds the door. The ball-type catch, as shown in figure 43 consists of a barrel holding a steel spring that pushes against a steel ball. This assembly fits into the bottom or top of the door. A beveled striker plate fits into the door frame. These catches are very easy to install, since they require only one hole to accommodate the barrel and a small mortise or "gain" for the striker plate.

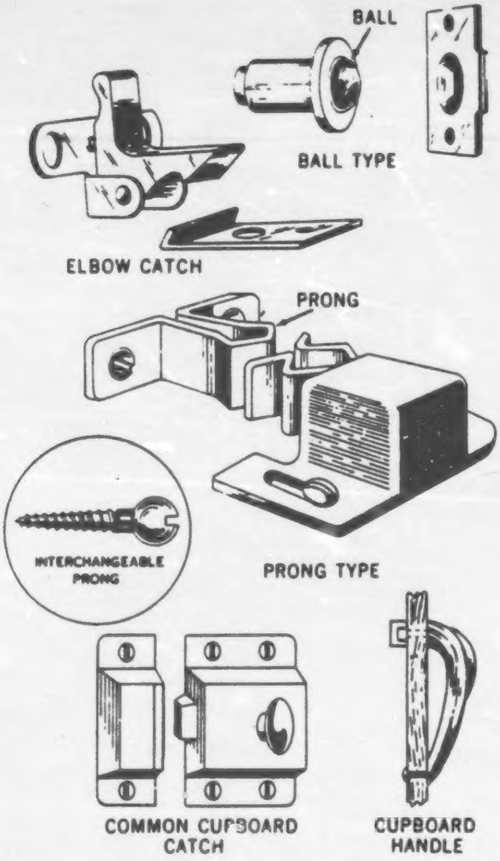


Figure 43. Types of cabinet catches.

6-54. *c. Prong-type catch*—This type of catch is similar to the ball-type catch, but there is no barrel, ball, or striker plate. A specially shaped prong that fits into a spring-type holder is fastened to the inside of the door. The holder is fastened inside the cupboard. It clamps over the prong and holds the door closed. The door will open easily with a slight pull when either of these catches is used.

6-55. *d. Cupboard catch*—The most common catch used on cupboards is a simple lock that opens with a knob instead of a key, as shown in figure 43. It may be used on either a single or double door. The lock is fastened to the face of the door, and a striker is fastened to the frame of the opposite door. Many other types of catches or handles are available for use on cubboard doors. The type to use is only a matter of choice. They should, however, match the surrounding fixtures.

6-56. *Door bolts.* Door bolts, as shown in figure 44, are used for the same purpose as elbow catches on double doors. They are installed inside at either the top or bottom of the left-hand door. The bolt is released from the inside with either a pull chain or lever, depending on the type of bolt used.

6-57. *Drawer pulls and knobs.* Drawer pulls or knobs, as illustrated in figure 45, made from either wood or metal are used for pulling drawers open. They come in such a large variety of sizes, shapes, and designs that it would be impossible to discuss them all. Pulls and knobs are usually fastened with a bolt-type fastener that passes through the front of the drawer.

6-58. *Miscellaneous hardware.* Numerous special hardware items are used in building construction. These items may be either rough or finish hardware, depending upon their use. A few of these special items are illustrated in figure 46. Let's see what they are.

6-59. *a. Timber connectors.*—Timber connectors are metal devices used to increase the joint strength in timber structures. Efficient connections for either timber-to-timber or timber-to-steel joints are provided by the several types of timber connectors. The appropriate type for a specific structure is determined primarily by the type of joint to be made and the load to be carried.

6-60. *b. Shelf brackets*—Shelf brackets vary from very simple angle braces to elaborate scrolled brass brackets. They are made for fast-

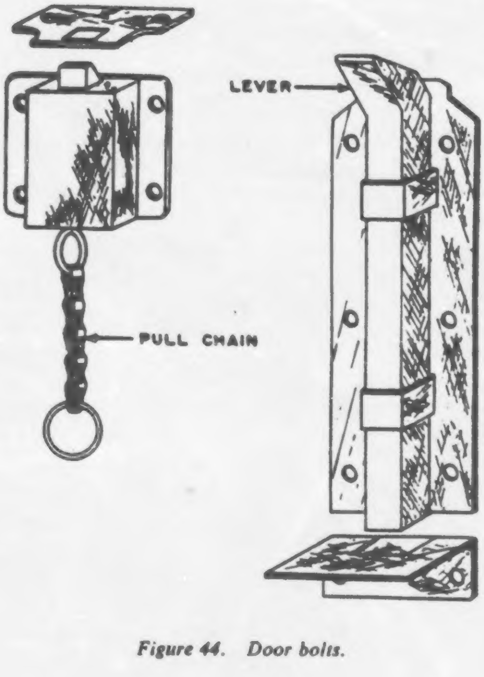


Figure 44. Door bolts.

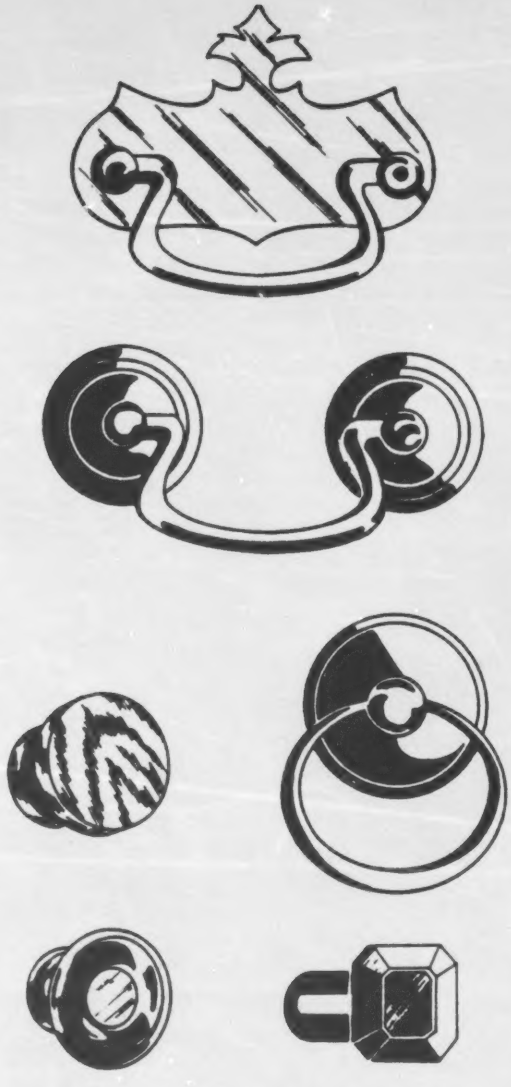


Figure 45. Drawer pulls and knobs.

ening an open shelf to a wall or for holding adjustable shelves in a cabinet.

6-61. *c. Joist hangers*—Joist hangers are used for fastening joists to girders and to eliminate toe-nailing, notching, and shimming. Metal bridging is available to be used between floor joists in the same manner as diagonal or crisscross bridging. This type of bridging is easy to install and makes a neat-appearing job. It is, however, more expensive than wooden bridging.

6-62. *d. Handrail brackets*—Handrail brackets are designed to hold the handrail for stairways. They are made in many designs and finishes, but all serve the same purpose. They must be fastened securely to a wall stud or a block installed between the studs. Many other hardware items commonly used by the carpenter will become familiar to you as you work with them.

6-63. *e. Hydraulic door closer*—These closers are used to prevent the door from slamming and thus damaging the door. Different types of closers are used; some are designed for screen doors and others for exterior and other types of doors. Follow the instructions included with each door closer when installing them.

6-64. When the building materials are delivered to the job, they should be arranged in the

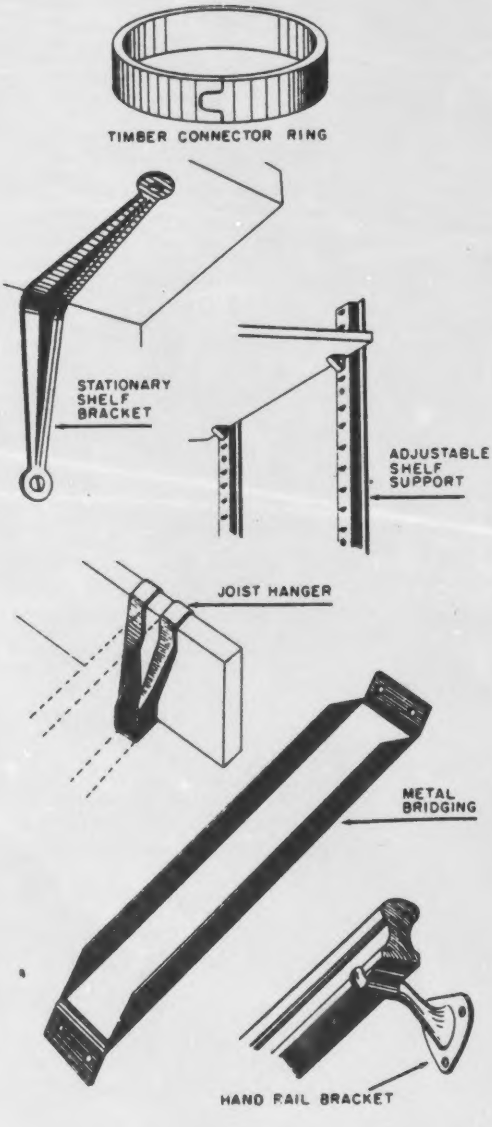


Figure 46. Miscellaneous hardware.

order that you will use them. That is, the sills, girders, joists, studs, roofing materials, etc. should be stacked near the building layout, since these items will be used first. These materials should be protected from the weather with rolled roofing or some other material. The materials for the interior should not be delivered to the job site until the roof and siding are installed.

7. Lumber

7-1. In this section we will introduce you to the various types of wood with which you will be working. The information will help you determine the proper wood to use for the jobs you will perform.

7-2. Since different types of wood have different characteristics which make them desirable for certain uses, it is important that you learn something about the types of wood and their characteristics.

7-3. We will discuss lumber in general. You will learn the types of trees that hardwood and softwood come from. Seasoning of this lumber will be explained as to the methods which are used to remove the moisture content.

7-4. Lumber sizes and the method used in the grading of lumber will be explained as well as the type of lumber best suited for a certain job. We will examine the causes of defects found in lumber and the preventive treatment used to prevent or control these defects.

7-5. If you know the materials you are going to work with, then you will be able to do a better job, so study this section carefully.

7-6. **Wood Types.** The two general groups of trees are as follows:

- Coniferous or cone-bearing trees consist of evergreens which have needle-type leaves. Pines, cedars, redwoods, spruce, fir, and hemlock are in the coniferous group. Woods obtained from these trees are called softwoods, although some are actually harder than some of our so-called hardwoods. All woods which are of a resinous nature are classified as softwoods.
- Deciduous trees consist of broad-leafed trees which shed their leaves each year. Examples of this group are oak, walnut, mahogany, maple, and gum. Woods obtained from these trees are classified as hardwoods and are nonresinous in nature.

7-7. We are interested in only these two groups of trees, because they normally furnish most of the lumber used for buildings, furniture, and other manufactured items.

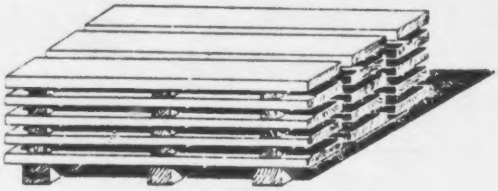


Figure 47. Method of seasoning wood.

7-8. **Seasoning.** After logs have been sawed, the boards, planks, or timbers are seasoned or dried to remove the excess moisture. This is one of the most important and difficult processes in the preparation of lumber. If the lumber is used for a large building or a piece of furniture, the excellence of the finished product depends largely upon the skill and care given to drying the lumber before it is used. The water contained in wood is either free water or imbibed water. Free water is the amount of water contained in the wood cell, and imbibed water is that which is absorbed by the porous walls of the cells. When wood dries, the free water evaporates first. Evaporation of the imbibed water causes the cell walls to shrink, which, in turn, causes the wood to shrink, warp, or split. The loss of moisture makes wood harder, stiffer, and lighter in weight. Lumber may be seasoned either by air drying or by kiln drying, or by a combination of these two. Chemical seasoning in combination with these two methods is used by some civilian industries for drying lumber.

7-9. *Air drying.* In air seasoning, the wood which is to be dried is piled in the open air with small planed spacer strips placed crosswise between each layer, as illustrated in figure 47. This allows air to circulate freely around each board. This is an effective but slow method of seasoning wood.

7-10. *Kiln drying.* A drying kiln is a large oven used to produce rapid evaporation of the moisture contained in green wood. Most large sawmills and similar commercial lumber processing plants have at least one drying kiln. Kiln drying is considerably faster than air drying and permits drying to a much lower moisture content.

7-11. **Types of Shrinkage.** Wood shrinks in three directions: (1) along the circumference, (2) along the diameter, and (3) lengthwise. The lengthwise shrinkage is so small that ordinarily it can be disregarded. The shrinkage around the circumference is from one to three times greater than the shrinkage along the diameter. Figure 48 illustrates the effects of shrinking. Note that the board sawed through the center is practically straight. The reason for this is that it is sawed at right angles to the annual rings. When lumber is sawed in this manner, the an-

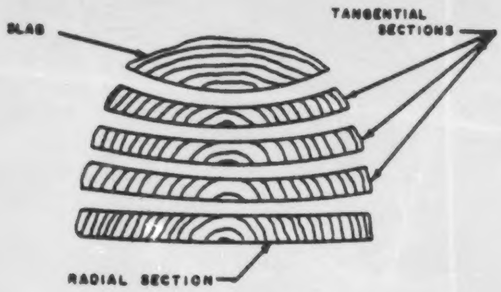


Figure 48. Effects of wood shrinkage.

nual rings are short and cannot be pulled in a circular direction. On the other boards, however, the annual rings are longer on one side than on the other; consequently, the pull is greater on one side, which causes the boards to bend or warp.

7-12. **Causes of Defects and Decay.** Grain deviation is a condition in which the grain does not run parallel to the plane of the board. It may be due to natural or artificial causes. The more common deviations are spiral, wavy, or curly figures, and distortions caused by an injury or knot and are called natural deviations. Artificial causes are involved when the plane of the saw cut is not parallel to the outside surface of a log. Knots are portions or parts of what once were tree limbs. As the tree grows, knots become embedded in the trunk. If the limb is still alive when the tree is cut, the knot is tight and is considered sound. Knots can be round, oval, or spiked, depending on whether the log is plain or quarter sawed.

7-13. *Molds, stains, and wood rot.* Molds, stains, and wood rot are caused by the destructive action of a large number of fungi. These are tiny microscopic plant growths. Molds attach themselves only to the surface of the wood and do little damage. Stain fungi discolor wood but do not destroy much of the structure. Wood rotting fungi break down the wood structure and in time reduce the wood to pulp.

7-14. *Insect damage.* Insects cause another form of deterioration in wood, similar to the results from fungi. The most prominent of these insects are termites and wood beetles. There are four conditions essential to the existence and growth of such insects: (1) moderate temperature, since the insects either die or cease to thrive at extremely high or low temperatures, (2) a moderate amount of moisture, (3) air, and (4) food, which is usually the lumber itself.

7-15. Since wood itself is the food upon which fungi and insects thrive, the wood can be impregnated with poisoned preservatives, such as creosote or zinc chloride. The following provide the best protection for ordinary construction:

a. Creosote is a brownish-black heavy oil, practically insoluble in water, and is derived by distillation from coal. It poisons the food supply of the fungi or insects and is not easily washed out of the wood. It is one of the best preservatives for wood in contact with the ground or exposed to weather. It has the disadvantages, however, of being dark in color, not taking paint well, and giving off a strong odor which makes its use in many places objectionable.

b. Zinc chloride is a salt which can be forced into the wood pores. It is colorless, odorless, and takes paint well. It is used in many places where creosote would be impractical. However, when exposed to rain or water, the preservative will slowly leak out of the wood unless protected by paint or other means.

7-16. **Methods of Treating.** There are several methods of treating wood with either creosote or zinc chloride. Of these, pressure treatment gives the most satisfactory results.

7-17. *Pressure treatment.* In this treatment, the wood is put on steel cars and run into long cylindrical tanks into which the preservative is pumped in liquid form and maintained under pressure for a sufficient time to force the preservative into the pores of the wood.

7-18. *Hot and cold method.* The hot and cold method consists of placing the material in a bath of hot creosote, maintained at about the boiling temperature of water for an hour or more, and quickly removing it to a bath of lukewarm creosote (about 100°) where it remains for another hour or so. The hot bath drives out some of the air and moisture in the cells of the wood; and when suddenly cooled in the other bath, the remaining air will contract and draw in a large amount of preservative. This method is not as satisfactory as the pressure method but is a very practical method in the field.

7-19. *Dipping.* This process is suitable only for preservatives of an oily nature. It consists of dipping the ends of posts or lumber in hot creosote at the boiling temperature of water for about 15 minutes. This system, while not the best, will add considerable life to the material.

7-20. *Painting.* This consists of coating or preferably pouring hot creosote over the wood. It is considered a satisfactory method for preserving wood in contact with the ground but is not as positive as other methods. Two coats are advisable, and care is necessary to work the creosote thoroughly into all cracks or crevices of the wood. In all of the processes, the protective treatment should be carried to at least 6 inches above the ground line. Only sound, dry wood should be used. Except where pressure treatment is used, the preservative is only at or near the surface and leaves the interior of the wood unprotected.

7-21. **Sizes of Lumber.** Lumber is cut to standard lengths and thicknesses at the mill. Softwoods are generally cut to even lengths, such as 10-, 12-, 14-, 16-, 18-, and 20-foot lengths, while hardwoods are cut in odd lengths. Boards average from ½ to 1½ inches in thickness, planks average from 1½ to 4 inches in thickness, and timbers are more than 4 inches thick. These thicknesses refer only to rough lumber as it comes from the saw. After the mill cuts the lumber to size, the boards are sent to the kiln or drying area for seasoning. During the seasoning operation, the boards lose some of their width and thickness as a result of shrinkage. After the boards are seasoned, they are sent to the planing mill where they are planed or dressed. For material less than 1½ inches in thickness, 1/16 inch is allowed for each planed or dressed surface. For material more than 1½ inches in thickness, ⅛ inch is allowed for each planed or dressed surface. An example of this is a mill-cut 1-inch board, dressed on both sides, which finishes out to be about ¾ inch thick. Loss in thickness of 1/16" + 1/16" + shrinkage due to seasoning equals about ¼-inch loss. Likewise, a 2-inch plank, dressed on both sides, finishes out to be about 1⅝ inches thick. Loss in thickness of ⅛" + ⅛" + shrinkage due to seasoning equals about a ⅜-inch loss. The width of any board cut at the mill takes a similar loss in width. A 6-inch board will dress out to only about 5⅝ inches in width, and an 8-inch board will dress out to only about 7½ inches in width.

7-22. Running the boards through the planer removes a portion of the wood from each of the four surfaces. This means that the actual size of dressed lumber is somewhat less than the size originally cut from the log. After finishing, a 1-inch by 6-inch board is more nearly ¾ inch by 5⅝ inches. However, such a board is commonly referred to as a 1 inch by 6 inch, which is the stock size. The following table shows some of the common stock sizes of lumber and their actual finished sizes:

Stock Size	*Actual Size*
1" x 2"	¾" x 1⅝"
1" x 3"	¾" x 2⅝"
1" x 4"	¾" x 3⅝"
1" x 6"	¾" x 5⅝"
1" x 8"	¾" x 7½"
1" x 10"	¾" x 9½"
2" x 2"	1⅝" x 1⅝"
2" x 4"	1⅝" x 3⅝"
2" x 6"	1⅝" x 5⅝"
2" x 8"	1⅝" x 7½"
2" x 10"	1⅝" x 9½"
4" x 4"	3⅝" x 3⅝"

7-23. These finished sizes and lengths are based on the linear (long) system of measurement rather than the metric system. Some foreign countries use the metric system instead of the linear system. If you are in a country using the metric system, a conversion of feet to meters or meters to feet is necessary. Table I converts inches to millimeters, and table II converts meters to feet and feet to meters. Ten millimeters equals one centimeter. One hundred centimeters equals one meter of 39.37 inches. In table 2, you can see that 1 meter = 3.28 feet, 10 meters = 32.81, and by adding these two numbers, 11 meters =

TABLE 1
INCH AND MILLIMETER CONVERSION

Millimeters to inches				Inches to millimeters			
Millimeters	Inches	Millimeters	Inches	Inches	Millimeters	Inches	Millimeters
1	0. 0394	17	0. 6693	1/32	0. 79	17/32	13. 49
2	. 0787	18	. 7087	1/16	1. 58	9/16	14. 28
3	. 1181	19	. 7480	3/32	2. 38	19/32	15. 08
4	. 1575	20	. 7874	1/8	3. 17	5/8	15. 87
5	. 1968	21	. 8268	5/32	3. 96	21/32	16. 66
6	. 2362	22	. 8661	3/16	4. 76	11/16	17. 46
7	. 2756	23	. 9055	7/32	5. 55	23/32	18. 25
8	. 3150	24	. 9449	1/4	6. 34	3/4	19. 04
9	. 3543	25	. 9483	9/32	7. 14	25/32	19. 84
10	. 3937	26	1. 0236	5/16	7. 93	13/16	20. 63
11	. 4331	27	1. 0630	11/32	8. 73	27/32	21. 43
12	. 4724	28	1. 1024	3/8	9. 52	7/8	22. 22
13	. 5118	29	1. 1417	13/32	10. 31	29/32	23. 01
14	. 5512	30	1. 1811	7/16	11. 11	15/16	23. 81
15	. 5906	31	1. 2205	15/32	11. 90	31/32	24. 60
16	. 6299	32	1. 2598	1/2	12. 69	1	25. 39

TABLE 2
FEET AND METER CONVERSION

Meters	Meters to feet									
	0	1	2	3	4	5	6	7	8	9
		3.28	6.56	9.84	13.12	16.40	19.68	22.97	26.25	29.53
10	32.81	36.09	39.37	42.65	45.93	49.21	52.49	55.77	59.06	62.34
20	65.62	68.90	72.18	75.46	78.74	82.02	85.30	88.58	91.86	95.14
30	98.42	101.71	104.99	108.27	111.55	114.83	118.11	121.39	124.67	127.95
40	131.23	134.51	137.80	141.08	144.36	147.64	150.92	154.20	157.48	160.76
50	164.04	167.32	170.60	173.88	177.16	180.45	183.73	187.01	190.29	193.57
60	196.85	200.13	203.41	206.69	209.97	213.25	216.54	219.82	223.10	226.38
70	229.66	232.94	236.22	239.50	242.78	246.06	249.34	252.62	255.90	259.19
80	262.47	265.75	269.03	272.31	275.59	278.87	282.15	285.43	288.71	291.99
90	295.28	298.56	301.84	305.12	308.40	311.68	314.96	318.24	321.52	324.80
Feet	Feet to meters									
		0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743
10	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.486	5.791
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50	15.240	15.545	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175

36.09 feet. For any number of meters from 1 through 99, you can use this chart. For higher numbers, simply add the proper number from the chart. If the tables are not handy, remember that the number of feet multiplied by .3048 gives you the number of meters, or the number of meters multiplied by 3.281 gives you the number of feet.

7-24. You must be careful in all phases of your construction, including making and using drawings, planning, preparing bills of materials, and ordering lumber from local overseas sources. If the lumber you use comes from a local overseas source, it would be advisable for your shop to have the necessary measuring devices available for your use.

7-25. **Grading of Lumber.** Grading of lumber is not an exact science, since the grade is determined visually by looking over the lumber and deciding to which grade it belongs. Although this inspection is performed by highly trained men, standards may vary somewhat in different sections of the country. However, the American Lumber Standards have been set up by the lumber industry and the Bureau of Standards of the United States Government. These standards are widely followed in grading lumber.

7-26. Lumber is divided into three general groups according to principal uses: (1) yard lumber, (2) structural timber, and (3) factory or shop lumber. Yard lumber is used for general building purposes and is graded into two general classifications, select and common. There are four different grades of select lumber: A, B, C, and D. Grades A and B are suitable for natural finishes, while grades C and D are for painted surfaces. Common lumber has five different grades: 1, 2, 3, 4, and 5. Number 1 and 2 common grades are suitable for use without any waste. Numbers 3, 4, and 5 are low grades of lumber with many knots, blemishes, and knotholes. Further explanation of grade classification for yard lumber is shown in figure 49. Structural timbers, those 4 inches or over in thickness and width, are graded according to the strength and use of the entire piece. Factory or shop lumber is intended for use in making articles where such defects as knots and knotholes may be removed in the manufacturing process. This type of lumber is graded on a basis of the proportion of usable lumber.

7-27. Practically all lumber has some defects or imperfections. The more common ones are (1) warping, (2) grain deviation, (3) knots, (4) compression wood, (5) injuries from handling, (6) shakes, (7) checks, and (8) molds, stain, or wood rot. Warping was explained previously in this chapter in connection with seasoning and shrinkage.

7-28. **Cuts of Lumber.** Let us now examine the various sizes and cuts of lumber which you will most likely use in your job.

7-29. Lumber is sawed from logs in two distinct ways, with the plane of the cut either radial or tangential to the annual rings. Lumber

- Total products of a typical log arranged in series according to quality as determined by appearance
  - Select--Lumber of good appearance and finishing qualities.
    - Suitable for natural finishes.
      - Grade A--Practically free from defects.
      - Grade B--Allows a few small defects or blemishes.
    - Suitable for paint finishes.
      - Grade C--Allows a limited number of small defects or blemishes which can be covered with paint.
      - Grade D--Allows any number of defects or blemishes which do not detract from a finish appearance, especially when painted.
  - Common--Lumber containing defects or blemishes which detract from a finish appearance but which is suitable for general utility and construction purposes.
    - Lumber suitable for use without waste.
      - Nr 1 common--Sound and tight knotted stock. Size of defects and blemishes limited. May be considered watertight lumber.
      - Nr 2 common--Allows large and coarse defects. May be considered grain-tight lumber.
    - Lumber permitting waste.
      - Nr 3 common--Allows larger and coarser defects than Nr 2 and occasional knot holes.
      - Nr 4 common--Low-quality lumber admitting the coarsest defects such as decay and holes.
      - Nr 5 common--Must hold together under ordinary handling.

Figure 49. Grade classification for yard lumber.

cut on a tangent to the annual rings is known as plain sawed, as illustrated at the bottom of figure 50. When the cut is in a radial plane (parallel to the wood rays), the lumber is known as quarter sawed, as shown at the top of figure 50. Plain-sawed lumber is usually cheaper than quarter-sawed lumber, because it can be cut faster from the log and with less waste. It is also more likely to warp when drying. The figures or designs formed by the annual rings and other grain deviations show more clearly in plain-sawed lumber. Quarter-sawed lumber shrinks and swells less than plain-sawed lumber. It also cups, twists, or warps less and does not surface-check or split as badly during seasoning or while in use. Quarter-sawed lumber wears more evenly and holds paint better.

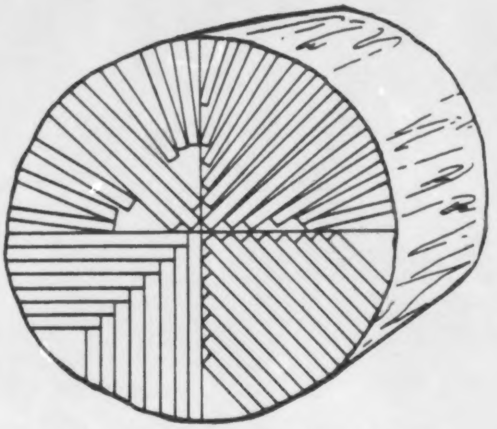
7-30. After lumber is dried and cut, large planers smooth the surface and remove all saw marks and roughness. Lumber that has been smoothed is designated as "finished" lumber and is ready for use in buildings.

7-31. **Types of Finished Lumber.** In addition to plain boards, planks, and timbers, lumber for the building and furniture trades is manufactured in matched, grooved, and beaded boards, shingles, laths, moldings, veneers, and plywoods.

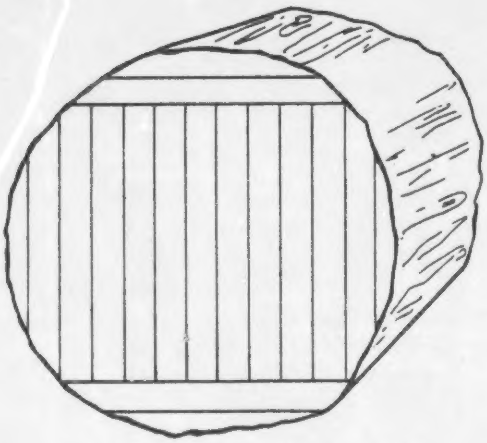
7-32. Matched, grooved, and beaded boards come in the following common styles: lap sheathing, which consists of wide boards, rabbeted, or grooved on the edges and used to cover the framework of wooden buildings; shaped and beaded sheathing, which is narrow boards of better grades used for partitions and wainscot; and siding, which consists of matched or shaped boards for the covering of frame buildings and which is nailed to the sheathing.

7-33. Moldings are made in a great variety of shapes for different purposes. The picture mold, shown in "A," figure 51, is placed against the wall flush to the ceiling. Some carpenters prefer to lower it 12 or 16 inches below the ceiling. The cornice mold, shown at "B," is nailed to the wall and ceiling. The chair rail, shown at "C," may be placed on the wall at any height, usually 48 inches from the floor. The panel mold, shown at "D," is used to divide wall spaces into panels. Shelves in closets rest on cleats, illustrated at "E" in figure 51.

7-34. Veneers are very thin sheets of wood, usually cut from more expensive woods. They are glued to more common woods either for the sake of appearance, durability, or both. Veneers are cut by three distinct methods: (1) sawing,



QUARTER SAWED - HARDWOOD
OR
EDGE GRAIN - SOFTWOOD



PLAIN SAWED - HARDWOOD
OR
FLAT GRAIN - SOFTWOOD

Figure 50. Plain- and quarter-sawed lumber.

(2) slicing, and (3) rotary cutting. Sliced veneers are cut on a machine having a large fixed knife against which the log is pushed. Each time the log is pushed over the knife, a thin sheet from 1/28 to 1/20 inch in thickness is cut. Rotary-cut veneers are cut from a round log on a very large specially constructed lathe. The log is turned between centers while a knife is pushed against it. As the log revolves, one continuous slice of uniform thickness is cut from the log.

7-35. Plywood, as the name implies, consists of an odd number of layers or plies of wood glued together so that the direction of the grain alternates with each layer. This is illustrated in figure 52. Plywood is made in various thicknesses, sizes, number of plies, and grades of lumber. Some examples of the uses of plywood are drawer fronts, doors, and furniture.

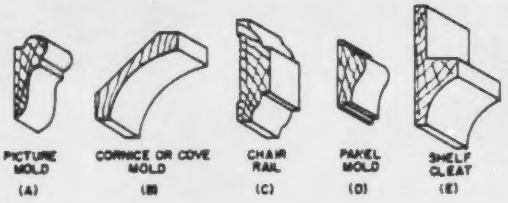


Figure 51. Trim members.

7-36. **Storage of Lumber.** Lumber in the yard should always be stacked at least 6 inches off the ground so that air circulation will reach the center of the stack. This is done by placing strips (dunnage) at various intervals between each layer at right angles to the lumber, allowing a maximum amount of air to circulate freely throughout the entire stack. Figure 47 illustrates how the strips separating the layers are placed in line with one another.

7-37. Lumber should be delivered to the job in small quantities so that it is used rapidly, especially if it must be stacked outside. The lumber should be stacked so that the boards to be used first are on top. This prevents damage from excessive handling. Finished lumber should never be delivered to the job until it can be stored inside, regardless of the climate or weather. The heat from the sun will cause as much damage to the lumber as excessive moisture. If finished lumber must be stored outside, it should be covered with a canvas tarpaulin or some other suitable covering.

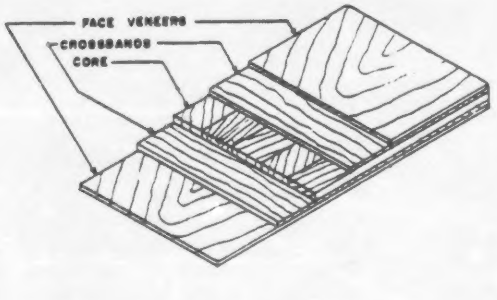


Figure 52. Plywood layers.

CHAPTER 3

Handtools

HAVE YOU EVER wandered through a new housing development as the various houses were being constructed? If you have, you've seen carpenters doing all sorts of work. Some will be nailing studs into place, some may be installing siding or flooring, others will be cutting rafters, and some will be installing interior trim or building cabinets. All of these men are using the many different tools of the carpentry trade.

2. It has been said that a good craftsman can be recognized by his tools. If this is true, the carpenter is one of the better examples. The quality of a carpenter's woodworking is greatly affected by the kind of tools he uses and their condition. The right saw, the proper chisel, the correct size of drill bit all add to the quality of the finished work.

3. Woodworking tools are sturdily built and will last a long time with proper care. Keep your tools in a suitable box to prevent damage to them, especially tools with cutting edges. When your tools (hand and power) are not in use, they should be kept clean. Your handtools, when not in use, should have a light coat of oil placed on them to prevent rusting. Your power tools should be oiled, when required, to keep them in good operating condition. A mark of a good craftsman is his well-kept tools.

4. Since your work in the Army is to be carpentry, we have, in this chapter, given you some information on the proper types of tools, their use, and their care. We haven't tried to tell you how to use them, because your supervisor will assign you to a trainer who will teach you their use. We're going to start our discussion of tools with those tools used for boring holes.

8. Care and Use of Boring Tools

8-1. Many types of carpentry work require the boring of holes through various wood sections. The size of the holes will vary from the small sizes up to the 1-inch size needed in fastening truss chords and compression members together. Let's begin with the auger bits.

8-2. **Auger Bits.** Auger bits range in size from ¼ to 1 inch. Sizes are available in sixteenths of an inch; thus a 1-inch bit is marked with a 16. If you ever got into dad's workshop, you'll recognize the auger bit we've shown in figure 53. You'll also remember the brace into which you placed the bit so that you could turn it to drill the hole. Take another look at figure 53. See the part of the bit marked "spur." This is the part of the bit which helps you to start the hole. It's made like a screw, and it pulls the bit into the wood as you turn the bit. The parts marked "nib" and "lip" are the cutting parts. The "twist" portion elevates the shavings out of the hole. The "shank" ends in a "tang" which [illegible] into the brace to turn the bit.

8-3. *Expanding auger bits.* Quite often you'll need to bore a hole larger than 1 inch in diam-

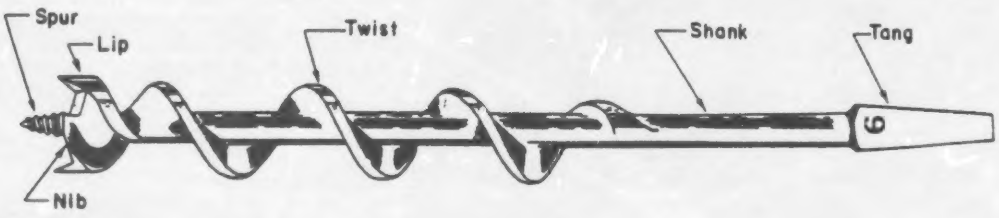


Figure 53. Auger bit.

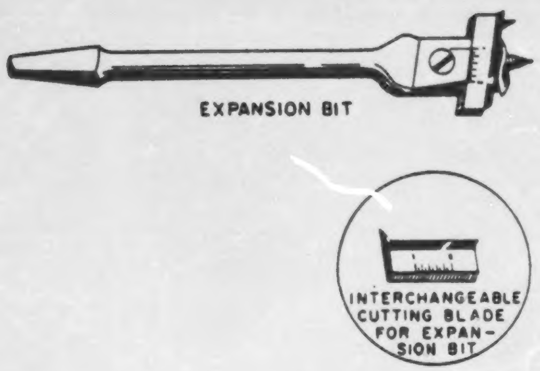


Figure 54.

eter, such as when you have to install a door lock. To drill these larger holes, there is an expansion bit. If you'll look at figure 54, you'll get an idea of what it looks like. Notice that the cutting bit includes a scale so that you can adjust the size. Usually, two cutting bits are furnished with each drill. The screw shown in the illustration is used to lock the cutting blade into position. The screw must be tightened to prevent the blade's moving and changing the size of the hole. As you can see, this bit also has a tang to fit into the brace.

8-4. *Foerstner bit.* This is a special bit used largely in pattern work. However, it can be used for other work as you become more adept in its use. (See fig. 55.) Notice that it has no spur at the center to guide it into the work. The circular rim of this bit acts as the guide.

8-5. *Care of auger bits.* As you remember from figure 53, both the nib and the lip of the auger bit cut the wood. To cut a clean, splinter-free hole, these cutting parts must be kept sharp. The spur must be kept sharp so that it will properly guide the bit. Because these are all keen edges, they should be protected from damage through contact with other tools. Store bits in a special case, or wrap the points with a rag to protect the cutting edges. When sharpening is necessary, do it properly and carefully. To sharpen the spur, hold the bit in one hand with the twist resting on the edge of the bench. Turn the bit around until the spur to be sharpened comes up. File the side of the spur with a small flat file, being careful to keep the original bevel.

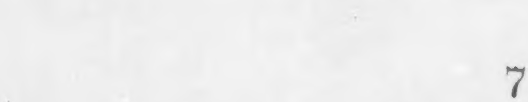


Figure 55. Foerstner bit.

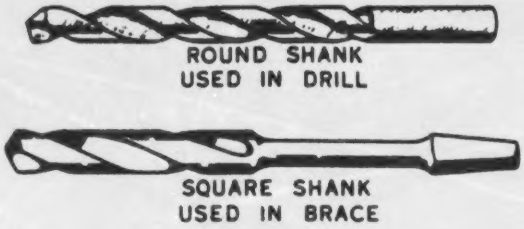


Figure 56. Twist drills.

8-6. **Twist Drills.** Quite often carpenters must drill holes in metal to which some type of wood facing or trim will be bolted. Drilling holes in metal requires a special type of drill called a twist drill. You've seen them in many shops. Usually, they are driven with an electric drill. Some twist drills, however, are made with a tang and can be used in a brace. Both types are shown in figure 56. Sizes are marked on the shank or the tang. They range in sizes from wire gauge numbers, through the lettered drills and those sizes in fractions of an inch. Standard-type twist drills are suitable for wood and soft metal drilling. They can also be used for drilling common steels if they are not turned too fast or if too much pressure is not used. High-speed drills should be used if a high-speed electric drill is used. Always slack off on the pressure as the drill is about to break through. This will often prevent skinned knuckles and will also help to prevent the drill from breaking. Twist drills should be sharpened on a bench grinder, using a tool rest. Be careful to retain the shape of the cutting lip and the angle of the point. Cool the drill point in water often as you sharpen it. If you don't cool the bit, the metal will be burned (turn blue), and the temper of the metal will be destroyed and the usefulness of the bit lost. File lightly until a fine burr appears on the outside. To sharpen the lip, hold the bit firmly in one hand with the worn point down on the edge of the bench, slanted away from the hand. File from the inside out toward the cutting edge. Remove the burrs, and your bit is sharpened.

8-7. **Countersink Bits.** Figure 57 shows one type of countersink bit you will use for making

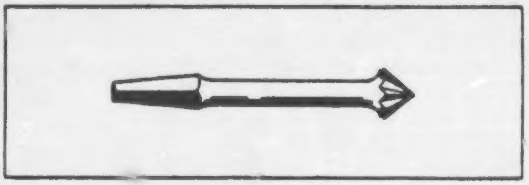


Figure 57. Countersink bit.

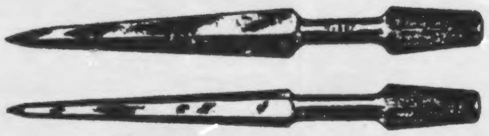


Figure 58. Reamers.

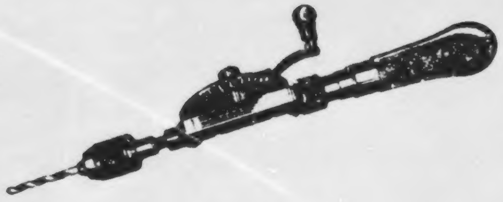


Figure 60. Hand drill.

a conical-shaped enlargement of a hole for setting the head of a screw. This type of bit, with a tang, is used in a brace, illustrated later in this section.

8-8. **Reamers.** A reamer is a long, tapered cutting tool for enlarging holes. It is used mainly by machinists but sometimes you might use one for enlarging holes in hinges and other types of hardware. Most reamers used in woodworking have a tang, as shown in figure 58.

8-9. **Brace.** The common bit brace is used to hold auger bits, twist drills, countersinks, expanding bits, Foerstner bits, and reamers which have shanks and tangs. Figure 59 shows the ratchet brace.

8-10. **Hand drills.** You will use hand drills to bore pilot holes for nails and screws. The hand drill is held with one hand on the handle and is operated by turning the crank with the other. Figure 60 shows a hand drill.

9. Care and Use of Cutting Tools

9-1. Cutting tools, like the boring tools, have sharp edges and points which need sharpening and protection. The edges also present hazards for the unknowing or careless worker. The true craftsman in carpentry is an expert in using the right tool in the right way. You can recognize him by the way he works. The common wood butcher is easier to recognize. He usually has bandages on his fingers.

9-2. Cutting tools may be classified as tooth cutting, sharp-edge cutting, smooth facing, and rough facing tools. With all of these tools available, you can choose the ones to do exactly the job you want done. Some cutting tools are fast, some are precise, and they are all good for certain jobs and unsuitable for others.

9-3. **Tooth Cutting Tools.** Handsaws of most interest to the carpenter are the ripsaw and crosscut saw. The common handsaw which you will use has a thin, flat blade of flexible steel, with a row of teeth along one edge. It varies in length from 14 to 30 inches and is used in cutting building materials to prescribed or desired dimensions by hand. The preferred way to hold the saw is to place the index finger along the side of the handle, with the remaining fingers looped through the handle of the saw. You can hold the saw with all fingers looped through the handle. The building material is placed on sawhorses. The material has been lined or marked to specified dimensions and is ready for sawing. The saw cut is started, on the waste side or outside of the marked line, by making a few upward or pulling strokes. Short forward or pushing strokes are made to deepen the saw kerf to prevent the saw from coming out of the kerf while you are sawing. Care should be taken during this operation to avoid cutting your thumb. Long

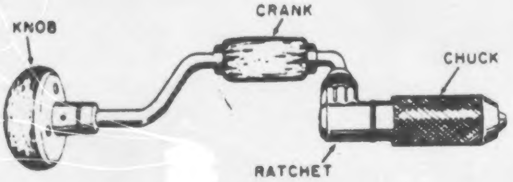


Figure 59. Brace.

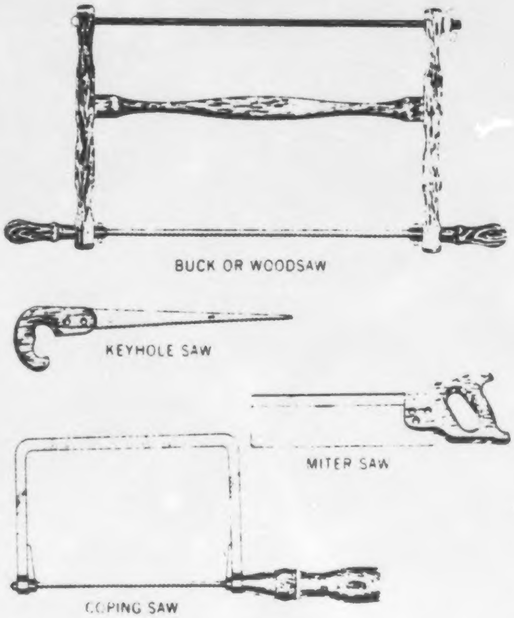


Figure 61. Types of saws.

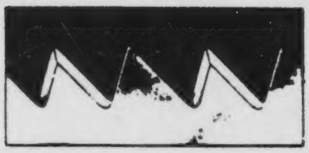


Figure 62. Teeth of crosscut saw.

even strokes with very slight pressure will give you the desired results in your sawing. Follow the marked line and keep your saw at the desired angle to make a square cut. Excessive pressure on the saw is referred to as riding the saw and should be avoided. Figure 61 identifies various types of saws.

9-4. *Saw teeth.* On a crosscut saw, each side of a tooth is filed to a cutting edge, giving the tooth a point. Each tooth on a crosscut saw is filed opposite to the one next to it. Results of this filing are illustrated in figure 62.

9-5. On a ripsaw, each tooth is filed (across the line of the teeth) to a sharp edge like a chisel, and every tooth is filed as shown in figure 63.

9-6. The teeth on a handsaw vary in size, depending upon the type of work to be done. For fine cutting, trim work, or cabinetwork, there may be as many as 12 teeth to the inch; for rough cutting, there may be 6 to 8 teeth to the inch. You will find a number stamped on the blade near the handle, designating how many teeth the saw has to the inch. For example, a crosscut saw with 12 teeth to the inch is called a 12-point crosscut.

9-7. The distance the teeth are set out beyond the side of the blade is known as the set. You set saw teeth to prevent the saw from binding and the teeth from choking up with sawdust. When setting, alternate teeth are bent to the same side, one tooth to one side and the next tooth to the other side, as shown in figure 64.

9-8. *Action of a crosscut.* You use the crosscut saw to cut across the grain of wood. Each crosscut tooth is a little two-edged knife. As the saw is drawn across the wood, it tears the fibers in two parallel rows. This cut is called a *kerf.*

9-9. *Action of a ripsaw.* You use a ripsaw to cut with or parallel to the grain of the wood.

Figure 63. Teeth of ripsaw.

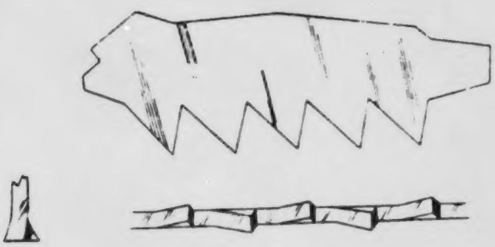


Figure 64. Setting of teeth on handsaw.

The teeth of a ripsaw are a series of little chisels set in two parallel rows. On each stroke of the saw, the sharp edges chisel off a little from the end of the wood fibers. This cut is also called a *kerf.*

9-10. *Saw filing.* The term "sharpen" is used here in a broad sense to include all of the operations required to put a saw in first-class condition.

9-11. When a saw comes from the factory, the teeth are all uniform in size, length, bevel, pitch, and set. After being used and sharpened a few times, the teeth become distorted. When this occurs, they must be filed to a straight line; this operation is called *jointing.* When you joint a saw, place it in a saw vise with the handle to the right. Starting with the butt end of the saw,

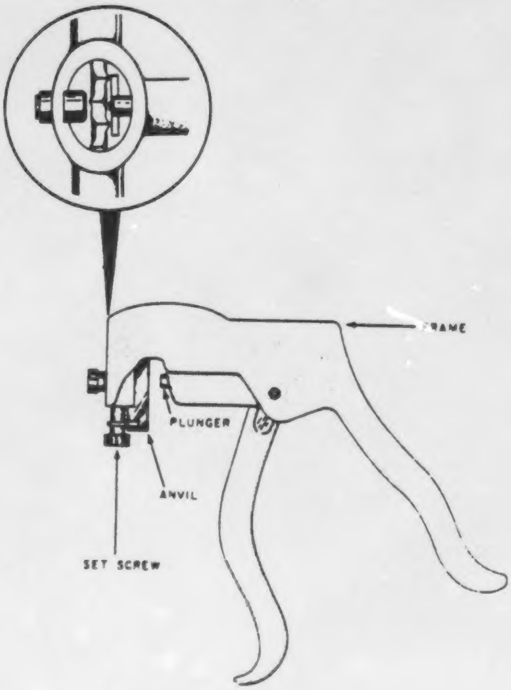
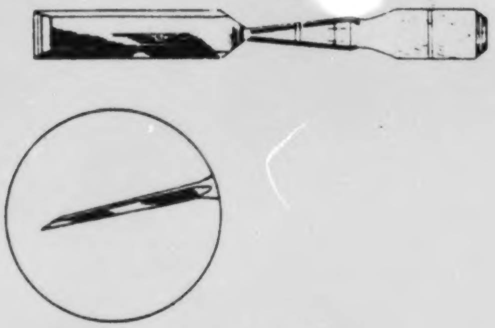
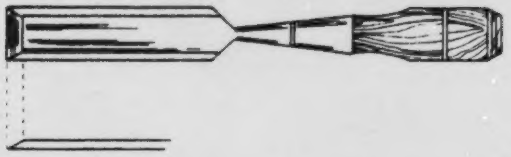


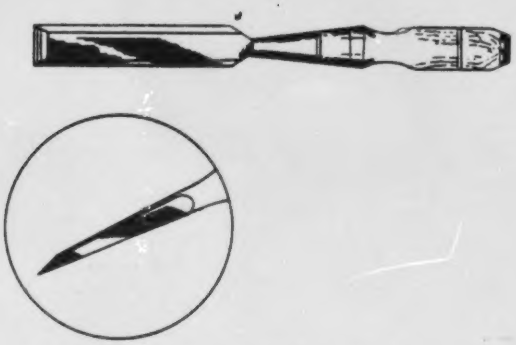
Figure 65. Saw set.



Paring chisel.



Firmer chisel.



Mortising chisel.

Figure 66. Types of chisels.

you lay a flat file on top of the teeth and move it lightly along the top of the teeth. Do not tip the file. Continue this operation until all the teeth are even, with a slight crown at the tip of each tooth. If you find the teeth are too short, which would make them hard to set, you must file them to the proper shape before they are set.

9-12. After the teeth are made even by jointing, they must be set. This means that every tooth will be bent a little to give the blade sufficient clearance. For a handsaw, the set should be half the thickness of the blade. This rule applies to both crosscut and ripsaws. When using a saw set (as illustrated in fig. 65), bend every other tooth (halfway from the point), starting at either end of the saw. Do not attempt to hurry this operation; it takes skill and practice to do it properly.

9-13. To file a crosscut saw, you place the saw securely in a saw vise with the handle to the left. Use a three-cornered file, and start filing from the butt end. Place the file between two teeth and incline it toward the small or tapered end of the saw. File both teeth at once, using one or more strokes with the same pressure on each stroke. Work down the length of the saw, then turn the saw around so that handle is to the right. Incline the file to the tapered end, which is now to the left, and again work down the length of the saw.

9-14. When you file a ripsaw, place the saw securely in a saw vise. File straight across the front of the teeth, using a three-cornered file, with the file handle lowered from 2 to 3 inches, giving a bevel on the top of each tooth that leans away from you. File down the length of the saw, starting with the butt end, using the same amount of pressure on each stroke.

9-15. After you finish filing the saw, lay it flat on a board and run the flat side of the file gently along the side of the teeth. Turn the saw over and repeat the operation on the other side. This is called *side dressing*. No setting may be necessary for the next two or three filings. In that case, side dress with an oil stone to remove the burrs.

9-16. A miter saw is used with a miter box. The saw is held in a horizontal position and can be adjusted to cut various angles. This saw is used to cut moldings and picture frames to fit. The saw can be adjusted to cut at right angles for small pieces of wood. Cutting a piece of molding to a specified angle can be done by setting the saw to the prescribed angle, inserting the piece in the proper position against the fence, and moving the saw back and forth across the material.

9-17. A coping saw has the blade inserted in a C-shaped metal frame, with the teeth pointed towards the handle. Cutting is done on the pull stroke. It will cut very sharp inside and outside curves, usually on thin stock. Inside curves must have a drilled hole through the material before the blade can be inserted and you start your cutting.

9-18. **Sharp-Edged Cutting Tools.** The tools considered sharp-edged cutting tools are the chisels and draw knives.

9-19. *Chisels.* In carpentry, the chisel is an indispensable tool and often the most abused. It is designed solely for cutting wood surfaces. You should never use a chisel for prying or as a screwdriver. A chisel is a flat piece of steel (of varying thicknesses and widths) with one end

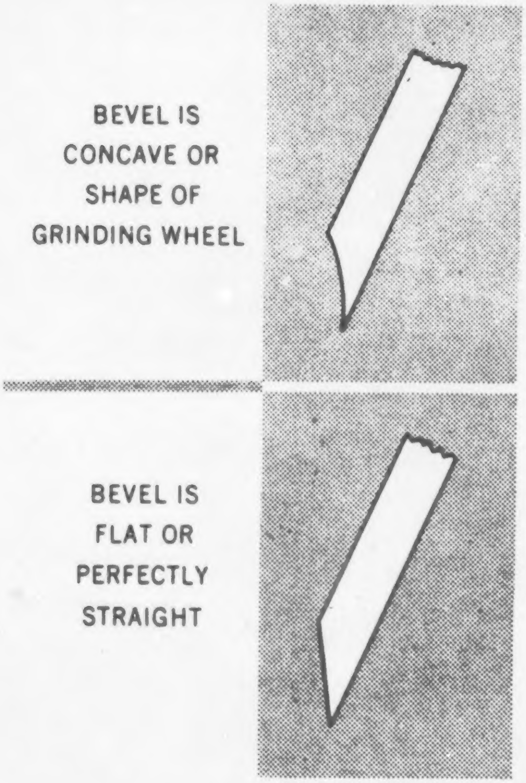


Figure 67. Honing a chisel.

ground to an acute bevel to form a cutting edge. There are many types of chisels. Figure 66 illustrates three types.

9-20. You will use a paring chisel for shaping and preparing relatively large surfaces. It is used with a steady sustained pressure of the hand and never driven with a mallet.

9-21. The term "firmer" implies that this is a more substantial tool than the paring chisel. Generally, you will use a firmer chisel for routine work, but you may use it for paring or light mortising. When paring, it is driven by hand pressure; but in light mortising, it may be driven with a mallet. Never use a hammer or metal tool to drive a chisel. Remember when driving a chisel, use wood to wood. This precaution will go a long way in preserving the handles of your chisels.

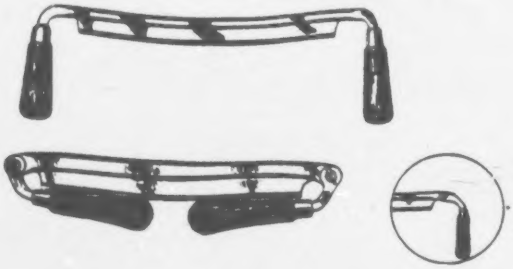


Figure 68. Drawknife.

9-22. A framing or mortise chisel is a heavy-duty tool which you can use for heavy work. These chisels have an iron ring fitted to the end of the handle to prevent splitting when it is struck with a heavy mallet.

9-23. Any chisel having a blade wider than 2 inches is called a *slick* chisel. Regular sizes range from 2½ to 4 inches. You use these on large surfaces where there is considerable material to be removed, or where unusual power is required.

9-24. Chisels should be absolutely flat on the back. This allows the chisel to take off fine shavings or a thicker cut if desired. The best chisels are made of selected steel with the blade widening toward the cutting edge. Blades are oil tempered and carefully tested. The tang or socket is welded to the blade to form a single piece. Handles are selected from thoroughly seasoned hickory wood.

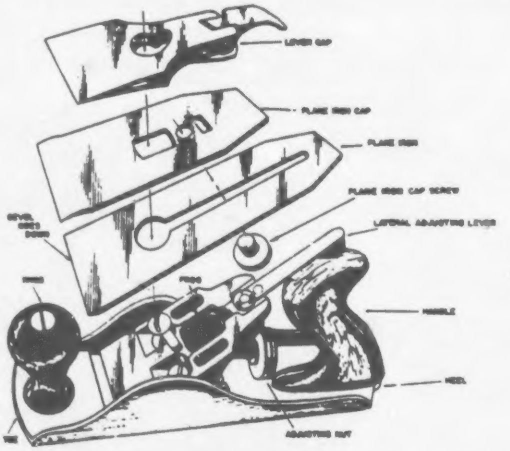
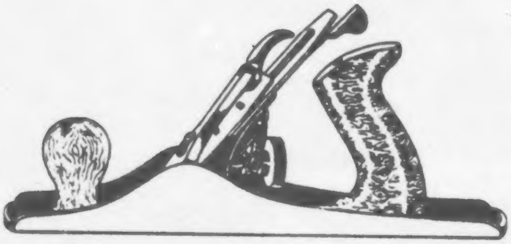


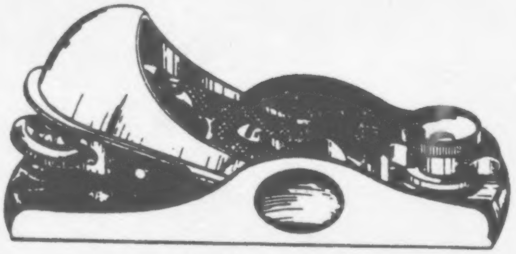
Figure 69. Hand plane.

9-25. When you are sharpening a paring chisel, make the taper long and at an angle of approximately 15°. The longer the taper, the easier the chisel will cut. A firmer chisel should be ground at an angle of not less than 20°; and for a framing chisel, the bevel should not be less than 25°.

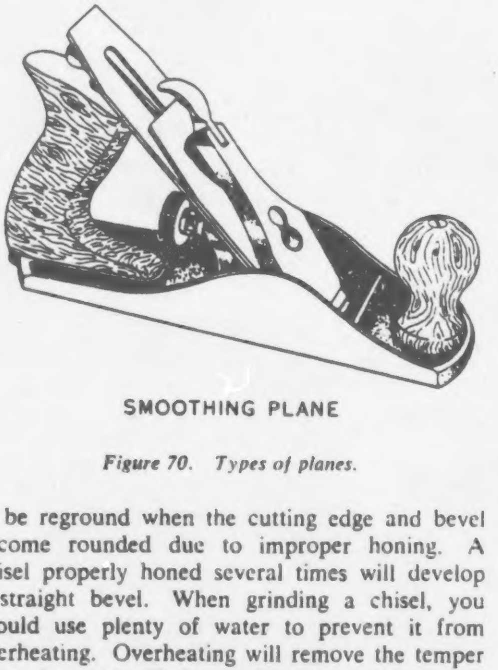
9-26. You may ask yourself, when is a chisel to be ground, and when is it to be honed? There are two reasons for grinding a chisel: (1) If the chisel is badly nicked, it will need to be ground until all the nicks are removed. (2) It will need



JOINTER PLANE



BLOCK PLANE



SMOOTHING PLANE

Figure 70. Types of planes.

to be reground when the cutting edge and bevel become rounded due to improper honing. A chisel properly honed several times will develop a straight bevel. When grinding a chisel, you should use plenty of water to prevent it from overheating. Overheating will remove the temper from the steel. If the steel starts to discolor or turn blue during the process of grinding, the chisel is definitely too hot. Never grind the back side of a chisel. Figure 67 illustrates a properly ground and properly honed chisel.

9-27. After the chisel is correctly ground, it is ready for honing, as shown in figure 67. It is the honing process that produces the deep cutting edge. The cutting edge of the bevel is called the toe and the back is called the heel. To hone a chisel, place a Carborundum stone or other suitable abrasive on the top of a workbench and apply a good grade of oil. Place the chisel with the toe and heel resting on the stone and move the chisel lightly across the stone. Moving the chisel across the stone wears the stone evenly and gives a better cutting edge to the chisel. Moving the chisel back and forth over the length of the stone tends to wear ridges and grooves in the stone, making it difficult to rest the bevel flat with the toe and heel. When a burr or wire edge appears on the flat side, it is removed by laying the chisel flat on the back side and moving it lightly across the stone. The chisel should be moved on the stone to form a rather elongated figure eight. This prevents wearing a groove in the stone. Repeat this honing process when the chisel gets dull or loses its edge. When not in use, the chisel should be wrapped in a cloth and stored.

9-28. *Drawknife.* This is another sharp-edged cutting tool. It consists of a large-edged blade with a handle on each end, as shown in figure 68. It is used to trim wood by drawing the blade toward the user. It is effective on narrow surfaces that must be considerably reduced. A desirable type for general work is one having folding handles. When using a drawknife with folding handles, lock the handles in the open position. When sharpening a drawknife, apply the same procedures used for sharpening chisels.

9-29. **Smooth Facing Tools.** These are classified as sharp-edged cutting tools in which the cutting edge is guided by the body of the tool instead of by the hands. The plane bit, for example, is positively guided by contact of the body of the tool with the work, giving a smooth cut in contrast with the rough cut made by hand-guided chisels. There are many kinds of smooth facing tools, such as planes and spoke shaves. The plane is a finishing tool and is used for smoothing wood surfaces. It consists of a wood or iron stock or a combination of the two, with the cutting edge projecting from a slot on the underside. The cutter inclines backward and has a chip breaker in front to dispense the shavings. Figure 69 shows a plane with the correct nomen-

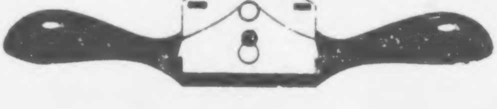


Figure 71. Spoke shave.

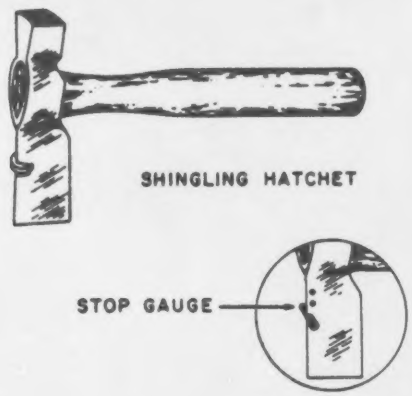


Figure 72.

clature of all parts. The plane is light and easy to use in finishing and bringing wood down to the desired thickness. You hold a plane with both hands and push it, with long strokes, away from you. There are many types of planes, each of which is designed for a particular purpose. Figure 70 illustrates the different types of planes.

9-30. *Smoothing plane.* The smoothing plane averages 12 inches in length. It is a short, finely set plane used for finishing uneven surfaces.

9-31. *Jack plane.* The jack plane is used for all-around work, primarily to give preliminary smoothness to lumber coming from the mill. It varies in length from 14 to 16 inches and removes a considerable amount of wood on each cut.

9-32. *Jointer plane.* This is the largest of the plane family and varies in sizes from 20 to 24 inches. The great length of this plane makes it possible to smooth a large surface or to make the edge of a board true so that two such surfaced areas will fit closely together.

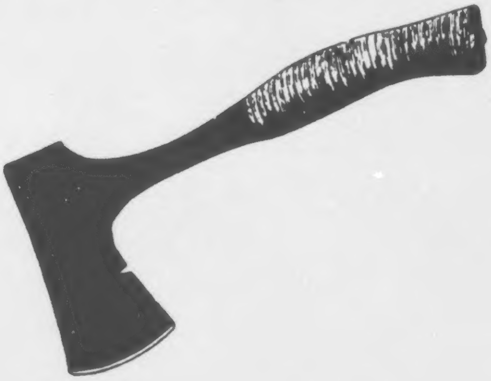


Figure 73. Hand axe.

9-33. *Block plane.* This is the smallest of planes. It varies in length from 3½ to 7½ inches, and can be used easily with one hand. Primarily, it is used for planing end grain or across the grain of wood. No chip breaker is needed to break the shavings because there are no shavings when planing across the grain.

9-34. Remember, the length of the plane determines the straightness of the cut. If you keep your plane bits sharp, they will produce a true and smooth surface. To receive the best service from your planes, the bit should always be ground and honed properly. When grinding and honing plane bits, the same rules apply as for wood chisels. The cutting edge should be straight on jointer, smoothing, and block plane bits; and slightly curved on jack plane bits.

9-35. Satisfactory results from the use of a plane depend on how it is used. On the forward stroke, hold the plane flat on the surface to be planed. On the return stroke, lift the back of the plane so that the cutting edge will not rub against the wood. This procedure prevents dulling the blade. When the plane is not in use, it should be placed on its side. When storing, withdraw the blade into the body of the plane. This aids in keeping the cutting edge sharp.

Figure 74. Axe.

9-36. *Spoke shave.* The spoke shave (illustrated in fig. 71) is a modified drawknife whose blade is set in a boxlike frame which forms a positive guide. The blade is adjustable, like that of a plane, to govern the thickness of the cut. Spoke shaves derive their name from the fact that they were used in making wagon spokes before the invention of automatic spoke-making machines. The blade is ground and honed in the same manner as those of the plane bit and chisel, except that for a spoke shave, a slip stone is more desirable.

9-37. **Rough Facing Tools.** Rough facing tools are classified as striking tools because the work is done by a series of strokes. The cut produced by this method is rough compared to cuts made by other tools.

9-38. *Broad hatchet.* The broad hatchet is the heaviest of the hatchets. You use it for sharpening and driving wooden stakes or similar types of jobs. The cutting edge is straight and

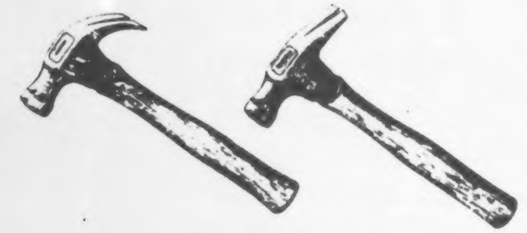


Figure 75. Clawhammer.

may be sharpened with either a single or double bevel, depending upon the type of work to be done.

9-39. *Half hatchet.* The half hatchet, used to nail flooring, has an extra long handle. The blade has a notch in the back edge that you can use for pulling nails. It may be used for "roughing out" to a line or for sharpening stakes. The cutting edge of this blade is straight and can be sharpened with a single or double bevel.

9-40. *Shingling hatchet.* The shingling hatchet (see fig. 72) has a square head with coarse serrations on the face. The blade is sharpened on the chopping edge for splitting shingles and along the back edge for cutting deadening felt or shaving shingles. An adjustable stop gauge is located on the front edge to measure the amount of shingle to the weather. You start shingle nails with a light blow and drive them completely with the second blow. The cutting edges are sharpened with a double bevel.

9-41. *Hand axe.* The hand axe (see fig. 73) has a curved cutting edge and a long, flat-faced peen. It is sharpened with a bevel on each side of the blade but differs somewhat from the double bevel because of the fan-shaped blade. The broad hatchet and half hatchet are sometimes referred to as hand axes.

9-42. *Axe.* This is similar to the hand axe but larger with a long handle. As you can see from figure 74, it is intended for heavy cutting and should be used with both hands. It is sharpened in the same manner as the hatchet.

10. Miscellaneous Tools

10-1. This section covers the different types of driving tools used by the carpenter, including the clawhammer, tack hammer, and mallets. Fastening tools to be discussed are the plain and automatic screwdrivers; plain, adjustable, and socket wrenches. Leveling tools consist of the straight-edge, common level, plum bob, and chalkline. Measuring tools discussed are folding rule and steel tape. The maintenance and use of all these tools will be explained.

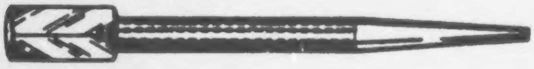


Figure 76. Nail set.

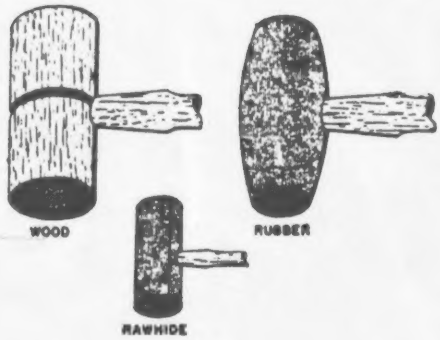


Figure 77. Mallets.

10-2. **Driving Tools.** There are various types driving tools designed for specific uses; however, the one most frequently used is the clawhammer.

10-3. *Clawhammers.* The better clawhammers are made from the best steel, which is carefully forged, hardened, and tempered. Hammers differ in the shape of the claw, curved or straight, and in the shape of the face, flat or rounded. The style of the neck, the weight, and the general finish of clawhammers differ according to the intended use. Figure 75 illustrates the straight and curved clawhammers. Clawhammers average in weight from 5 to 20 ounces. Hammers of good grades have hickory handles, made from well-seasoned, straight-grained stock. Other hammers of good quality have steel handles with shock-absorbing rubber grips.

10-4. When you are driving nails with a clawhammer, guide the nail with one hand and grasp the hammer with the other down near the end of the handle. You should avoid holding the hammer up near the neck. Use a wrist motion, tapping the nail lightly to start it, then using a few sharp blows to finish driving the nail. After the nail has been driven, it can be set below

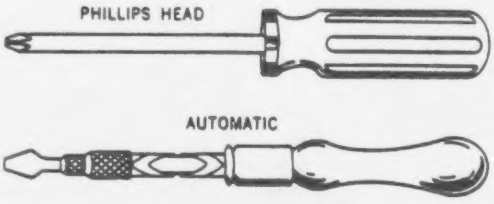


Figure 78. Screwdrivers.

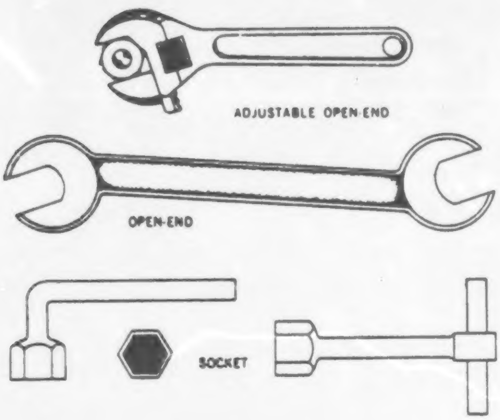


Figure 79. Wrenches.

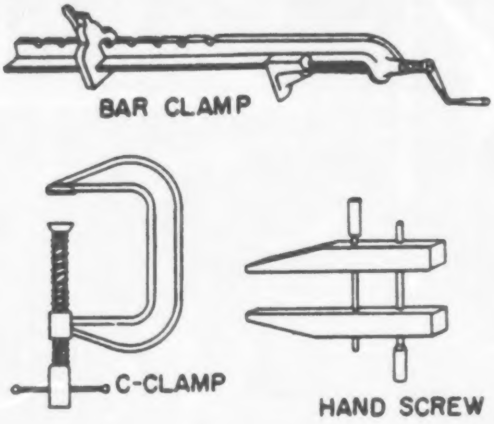


Figure 81. Retaining tools.

the surface with a nail set; this prevents hammer marks, or "cat paws," from marring the surface of the wood. Nail sets are made in several sizes. Figure 76 illustrates one type of nail set.

10-5. The claw of the hammer is used for removing nails. To properly pull a nail, you place a block under the claw for more leverage. If the nail is quite large, use a nail puller or wrecking bar.

10-6. *Tack hammers.* The tack hammer is lighter than the clawhammer, and one end is usually magnetized for holding and placing small brads or tacks, which are normally difficult to handle. It can be called a specialized tool because of its limited use.

10-7. *Mallets.* Mallets are in reality wooden hammers; although they are not considered a fastening tool, they are used in the same manner as hammers. You will use mallets primarily for driving chisels, wedges, etc. Depending on their use, mallets can vary in sizes from a few ounces to a few pounds. Many woodworkers make their own mallets to suit their personal touch. Three types of mallets are illustrated in figure 77.

10-8. **Fastening Tools.** Fastening tools are used to join parts or materials together with screws or bolts. Included in this category are screwdrivers and wrenches.

10-9. *Screwdrivers.* There are many different types, shaped ends, and lengths of screwdrivers. Figure 78 illustrates two types. The automatic screwdriver is a labor and time saver, especially where great numbers of screws are to be driven. The bits for this tool come in different sizes for slotted and Phillips head screws and can be changed to fit the different sizes of the screws. The automatic screwdriver has a ratchet assembly which you can adjust to drive or remove screws. You can also lock it in position and use it as an ordinary screwdriver.

10-10. *Wrenches.* There are several classes of wrenches: open-end, adjustable open-end, socket,

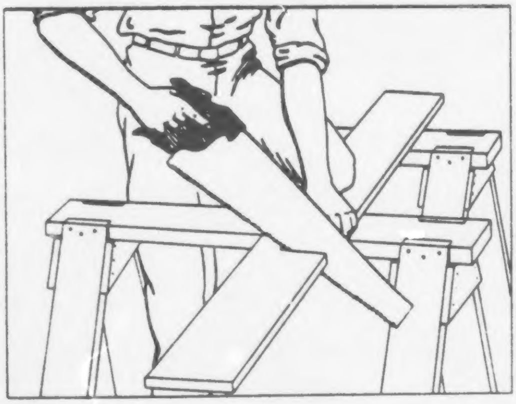


Figure 80. Sawhorses.

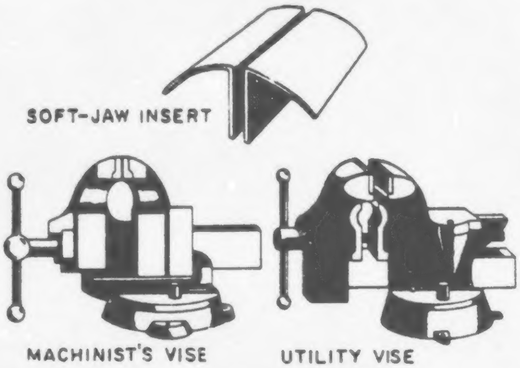


Figure 82. Vises.

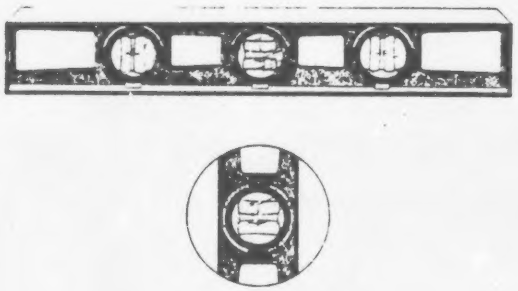


Figure 83. Common level.

etc. Figure 79 illustrates three types. A woodworker will use these wrenches when driving lagscrews or bolts, adjusting power tools and machinery, and for a variety of other uses.

10-11. **Holding Tools.** There are two general classes of holding tools: supporting and retaining.

10-12. Supporting tools consist of sawhorses or trestles and are used in various ways to support workers and material. Figure 80 shows a pair of sawhorses, such as you might use to support a piece of lumber which you are cutting.

Figure 84. Plumb bob.

10-13. Retaining tools consist of various types of clamps. These clamps fall into the following general categories: "C" clamp, double-screw clamp, and bar clamp. These clamps are illustrated in figure 81.

10-14. Vises can be fitted to the top of a workbench, and some are adapted to slide underneath the top of the workbench. Most vises used by carpenters are fitted with wood between the jaws to protect the work from scars, dents, and scratches. Figure 82 shows some of these vises.

10-15. **Leveling Tools.** The common level (see fig. 83) is used for both guiding and testing when bringing work to a horizontal or vertical position. The level has a long rectangular body of wood or metal which has a built-in glass spirit tube on its side and near the end. Each tube contains a nonfreezing liquid with a small air bubble free to move within the tube. The side and end tubes are at right angles to each other. When the bubble of the side tube is centered with the hairline, the level is horizontal; and when you center the bubble of the end tube with the hairline, the level is vertical. By holding the level against a surface to be checked, it can be determined whether the surface is truly level or plumb. Levels should be hung up when not in use.

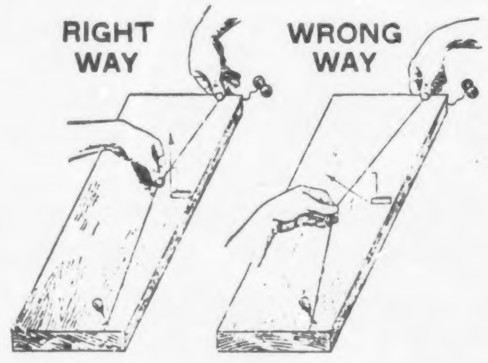


Figure 85. Snapping a chalkline.

10-16. *Plumb bob.* A plumb bob is made of metal, usually brass. It usually has a screw-type cap with a hole in the center. A string or plumb line is inserted through the hole and fastened inside. The bottom end has a point in direct line with the hole in the cap, as shown in figure 84. The string is absolutely perpendicular to the horizontal when the plumb bob is suspended on it. It can be used for the same purpose as the plumb glass on a level; however, the plumb bob is not accurate when used in the wind.

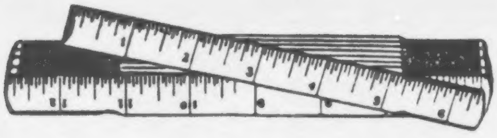


Figure 86. Folding rule.

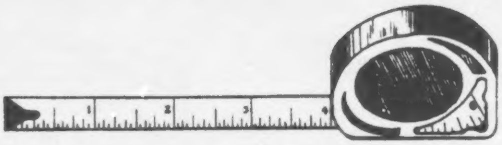


Figure 87. Steel tape.

10-17. *Chalkline.* This is a strong, light cord which is used to make a straight line between two widely separated points. To snap a straight line, chalk is rubbed on a cord and held taut between two points. The cord is then pulled straight up from the center and released to allow it to spring back into place. Some chalklines come in a metal case. Figure 85 shows you how to snap a chalkline.

10-18. **Measuring Tools.** Probably the most used and important tools that you must learn to use are those for measuring and layout work. Measuring tools for you, the carpenter, include rulers and tapes. The layout tools for you include various types of squares, dividers and compasses, and a marking gauge. The square is used for drawing specified angles that you need in carpentry work. Dividers and compasses are used to scribe circles or transfer measurements. In the same class as a compass is the carpenter's scribe which is used to scribe lines on building material for irregular joints. The marking gauge is used to mark lines parallel to a surface, an edge, or the end of a piece of building material. The manner in which you use these tools will determine the kind of work you will do. Measuring and layout must be done accurately, because the

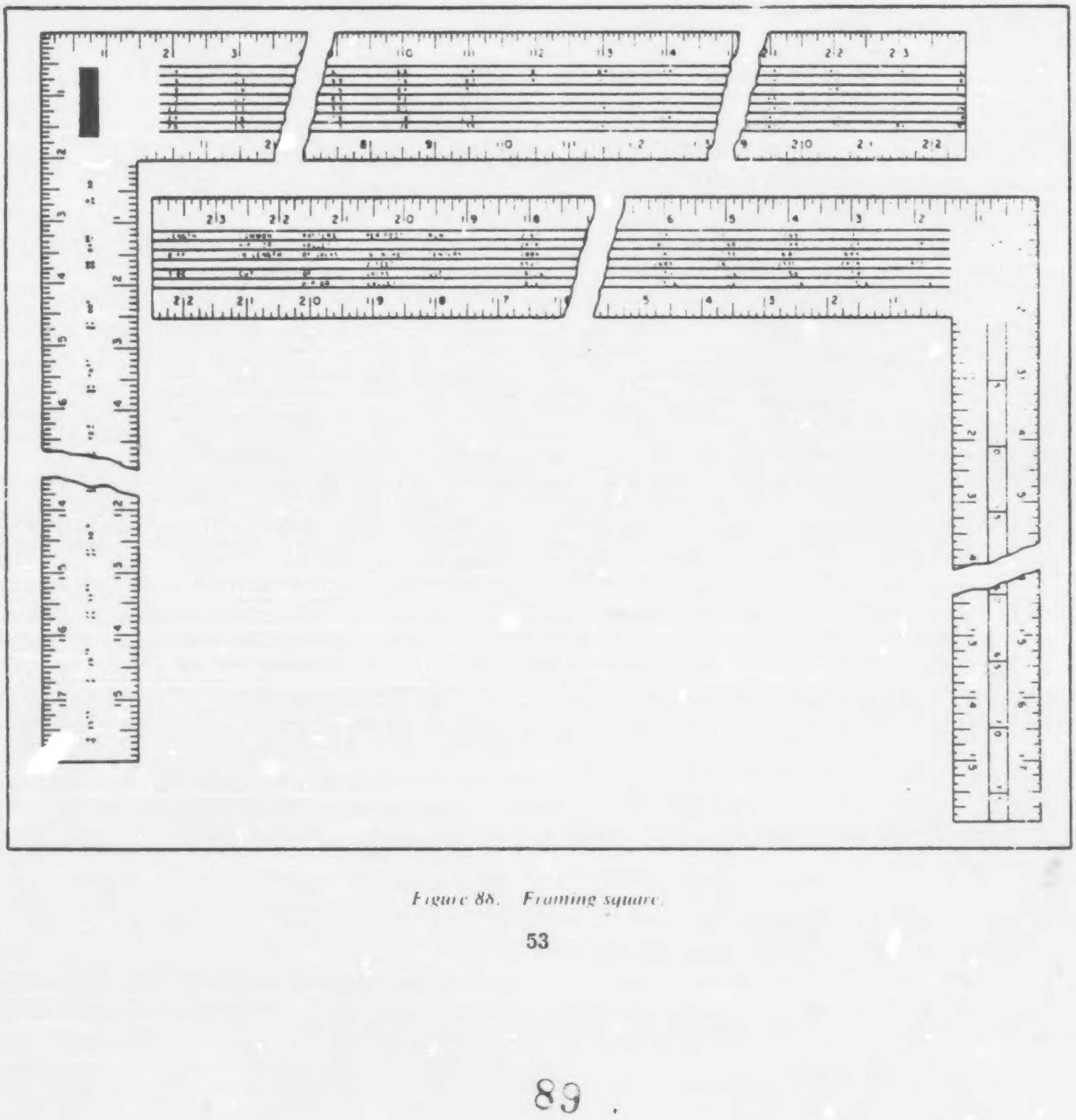


Figure 88. Framing square.

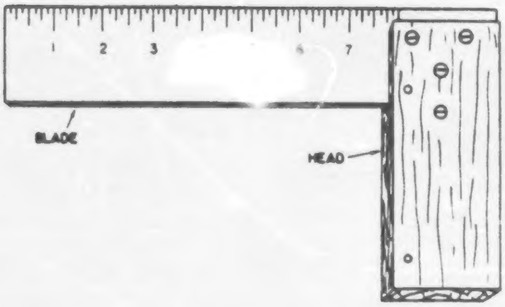


Figure 89. Try square.

final outcome of any project is affected by the measuring and the layout of every part. A very sharp pencil or a knife blade should be used for accuracy when measuring distances and laying out your desired work.

10-19. Measuring is accomplished by laying out your ruler or tape from your starting point and measuring the required distance called for by your plan. Place a mark opposite the required distance and square or angle the line as required by your desired layout.

10-20. *Folding rule.* The folding rule is made from boxwood and has a concealed joint or rivet that holds it stiff and rigid when opened. Usually 6 feet in length, it is marked off in feet and inches and graduated in sixteenths of an inch. Figure 86 shows the folding rule most often used by carpenters.

10-21. *Steel tape.* In recent years, the flexible steel tape has been replacing the folding rule. It is marked off in feet and inches and graduated to 1/16 inch. The flexible steel tape is housed in a metal casing with a spring attachment, which retracts it into the casing when the end is released. This type of rule is desirable because of its compactness and suitability for taking inside measurements. Figure 87 illustrates one type of flexible steel tape.

10-22. *Framing square.* In construction work, especially in house framing, the framing square is an invaluable tool. The framing square has a use that is common to all squaring devices. It is used in checking the squareness of building materials and the squaring or angling of a mark placed on the building material. One arm of the square is placed up against the edge or face of the building material. The other arm with measuring units on it is placed next to the desired mark on the building material, and a line is drawn across the material to the desired length or depth. Much could be written on the framing square because of its many uses. You will study the framing square in more detail later. In this section, we will limit our discussion to the correct nomenclature of parts and the various tasks for which it can be used. Figure 88 illustrates the framing square and its principal parts. The body of the square is the wider and longer member; the tongue is the shorter and narrower member. The face is the side visible both on the body and tongue when the square is held with the tongue in the left hand and the body pointing to the right. The square most generally used is one with a 16-inch tongue and a 24-inch body. The various markings on a square are scales and tables.

10-23. The framing square is a versatile tool and you can use it for many tasks. It can become a calculating machine, a means of solving mathematical problems; you will use it for laying out common, valley, hip, jack, and cripple rafters in roof construction, and for laying out stringers for steps. As you progress in this course, you will become familiar with the framing square and you will have an opportunity to study its various uses in more detail.

10-24. *Try square.* The try square is so called probably because of its frequent use as a testing tool when squaring up wood stock. Figure 89 illustrates an ordinary try square. It consists of a steel blade 8 inches long at right angles to the stock, which is usually made of hardwood and faced with brass to preserve the wood from damage. The blade is usually provided with a scale divided into eighths of an inch.

10-25. *Miter square.* The term "miter" means any angle except a right angle, but as applied to squares means an angle of 45°. Figure 90 illustrates a miter square. It is similar to a try square, but the stock of a miter square has an angle of 45° set in the stock. When you are using the miter square, the 45° face of the stock is placed against the edge of a board; then the blade will be at a 45° angle with the edge of the board. The scale on the blade is graduated in inches divided into eighths.

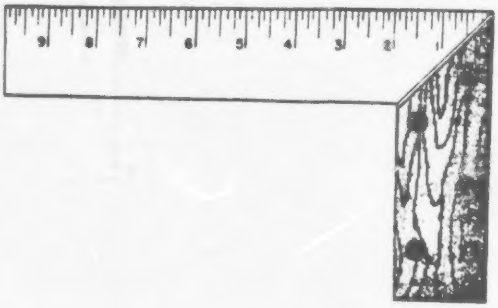


Figure 90. Miter square.

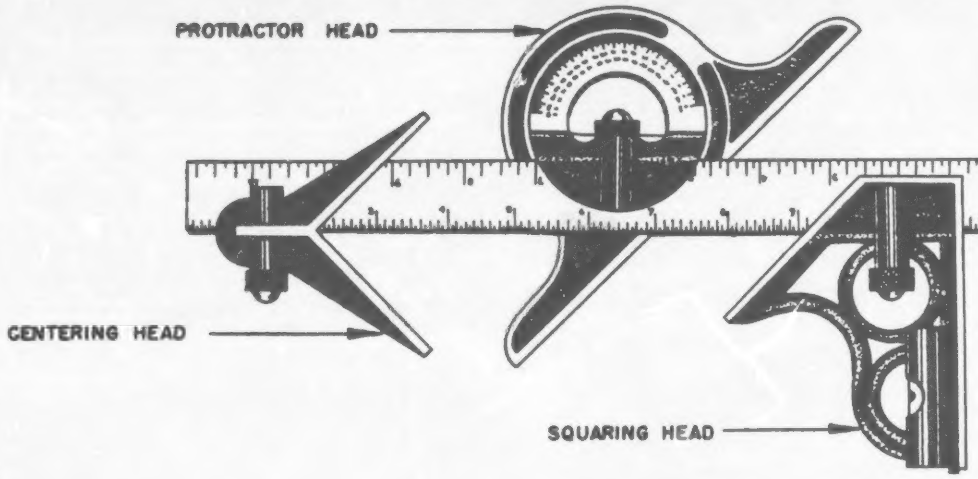


Figure 91. Combination square.

10-26. *Combination square.* The name "combination square" indicates that you can use it as a try or miter square. It differs from the try and miter square in appearance, and you can move the head to any desired position on the blade. The head slides in a groove located in the center of the blade. This groove also permits removal of the head in order that the blade may be used as a rule or straightedge. A spirit level is installed in the head, which permits it to be used as a level. A centering head, which can be substituted for the head, is used to locate the center of shafts or other cylindrical pieces. A scriber is also inserted in the head to be used for laying out work. The protractor head is used to set different angles. In the construction of this tool, the blade is hardened to prevent the corners from wearing round and detracting from its value as a measuring instrument. This combination square does the work of a rule, square, depth gauge, and level. Figure 91 illustrates the combination square.

10-27. **Sharpening Tools.** Two principal types of tools are used to sharpen other tools: stones and files.

10-28. *Grindstones.* I'm sure you've used a bench grinder, either at school or at your favorite filling station. Most bench grinders found in carpentry shops are equipped with two grinding wheels, one of course grit and one with fine grit. As you know, the grinding wheels are held to the shaft by nuts which squeeze the wheel between two special side washers. Grinding wheels are also rated by the turning speed they can withstand. Be sure you use stones made to withstand the rated revolutions per minute of the grinder electric motor. A tool rest is attached to the grinder frame and is adjustable for height as well as for distance from the stone. Most grinders are equipped with heavy-duty glass guards to permit watching as you grind. If there is no eye guard, you must wear safety goggles to protect your eyes. It is considered poor practice to use the side of the wheel for grinding. When the surface of the stone becomes irregular, or is filled with metal particles, a stone dressing tool, as shown in figure 92, should be used to restore a good grinding surface. A water container, for cooling parts being ground, is attached to the base of the grinder. Always cool the blades of tools you are sharpening to prevent destroying the temper of the metal with excess heat generated from grinding. Heavy grinding is done on the coarse wheel, and light or finish-type grinding is done on the fine grit stone. Most cutting edges should be finished by hand, using a fine oilstone.

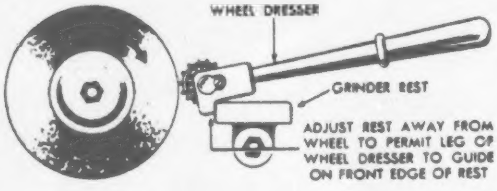

WHEEL DRESSER
GRINDER REST
ADJUST REST AWAY FROM WHEEL TO PERMIT LEG OF WHEEL DRESSER TO GUIDE ON FRONT EDGE OF REST

Figure 92. Emery wheel dresser.

10-29. *Oilstones.* Oilstones are used after the grinding operation to give a tool the keen, sharp edge required for smooth cutting.

10-30. *Artificial stones.* These stones have coarse, medium, or fine grades. Coarse stones are used for general work where fast cutting is required. Medium stones are used for sharpening tools not requiring a keen edge. They are recommended for sharpening tools used in working softwoods. Fine stones are used where a keen edge is desired. Cabinetmakers whose tools require a very find, keen edge use the fine type of stone.

10-31. *Files and rasps.* A file is a steel instrument used for cutting and smoothing metals and wood. A rasp is a very coarse file and differs from the ordinary file in teeth shape and size. Figure 93 illustrates various types of files, along with their correct nomenclature. Wood files are usually tempered to work lead or brass and should never be used on any harder surface.

10-32. When you are using a file, never allow it to drag on the backward stroke; it cuts only on the forward stroke. When you use a rasp the work should be firmly fixed in a vise and the rasp grasped in both hands, with one hand holding and the other applying a sight pressure to the tool.

10-33. **Pulling Tools.** Pulling tools are used for pulling nails, prying, and lifting. They are used extensively when dismantling buildings, crates, boxes, and other wood products. The following are classified as pulling tools.

10-34. *Nail puller.* A nail puller is used for removing nails, especially those that are driven flush or below the surface of wood. It consists of two jaws that set over the nailhead. Pressure is applied by a series of blows from the sleeve that fits over the handle and slides up and down. It is usually equipped with a guard to protect the hand from the sliding sleeve. The average length of a nail puller is 18 inches.

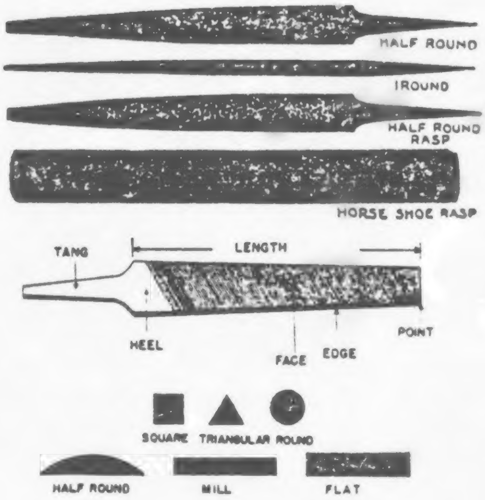


Figure 93. Various types of files.

10-35. *Wrecking bars.* Wrecking bars are usually made of forged, tempered steel. They are hexagonal in shape, with a curved slotted neck for pulling large nails and are used in dismantling and tearing down wooden structures. The average length is from 24 to 36 inches. A bar of the same type without a curved neck is called a pinch bar—its use is similar to that of a wrecking bar.

Woodworking Power Machinery

BY THE TIME you study this chapter, you may have been able to get into a woodworking shop. It probably had many of the types of power tools that will be described here. Over there in front of the row of windows is a cutoff saw. Farther down that same wall is the overarm saw. That's a drill press in the corner. Along the opposite wall is a wood lathe. But in the center of the shop where there's plenty of working room there's a table saw, a planer, and a jointer. Off to the side is a bandsaw. One corner of the shop is partitioned off to make a tool room. All the portable power woodworking tools are stored in this room. If you do not have access to woodworking tools now, the following information will assist you in becoming familiar with them. The shop floor is clear of sawdust and pieces, and the surface shines from the constant sweeping of the sawdust across its surface. It's a nice clean place to work—interesting too.

2. There's still a place for the craftsman, the real cabinetmaker who can handwork fine lumber into prized finished items. But, there's a lot of work to be done and there aren't many such workmen around, so power woodworking tools have been developed to speed the work and make it even more precise. There's a skill to be learned in operating these modern tools, too. And safety is very important.

3. You not only must learn how to operate these machines but also must know how to keep them in top working condition. In this chapter, we'll tell you how these machines operate and the type of work you can do when you learn to operate them. Probably the one tool, after the hammer, that people think about when they talk about carpentry is the saw; so let's start with the various types of power saws.

11. Sawing Machines

11-1. There is a variety of power-driven saws that you may encounter during your military career.

11-2. **Table Saw.** You can recognize the table saw because it has a boxlike base inside of which a shaft (arbor) is mounted. The top of the base is used as the worktable. There is a slot provided in the tabletop near the center, through which the saw blade is raised and/or lowered. The table is fitted with a fence which guides the work into the saw blade during ripping operations. Most table saws are equipped with a guard which covers the blade to prevent you from being injured. There are many types of saw blades. Figure 94 illustrates three types.

11-3. First is the ripsaw blade for general ripping or cutting with the grain; second, the crosscut blade for cutting across the grain; third, the combination blade for miter work. Look at the difference in the shape of the teeth in these blades, as shown in figure 94.

11-4. Also used on the table saw, the dado head, a special set of blades for cutting grooves, rabbets, tenons, and dados, is shown in figure 95. It contains two 1/8-inch-thick outside blades and an assortment of inside chippers of different thicknesses. By using a combination of this assortment, you can cut grooves from 1/8 inch to 2 inches wide.

11-5. The first operation that we will examine is ripping. When you trip a board, adjust the blade so that the cutting teeth project about 1/4 inch above the wood to be sawed and set the ripping fence to correspond with the desired width of the board to be cut, making sure that it is clamped in place. Push the wood into the blade and press it against both the table and ripping fence. If you are ripping narrow strips of wood, use a push stick instead of your hand to push the wood into the saw.

11-6. Crosscutting can be done with either a crosscut or miter blade. To make a crosscut, you remove the ripping fence to prevent it from interfering with the crosscut guide. Place the

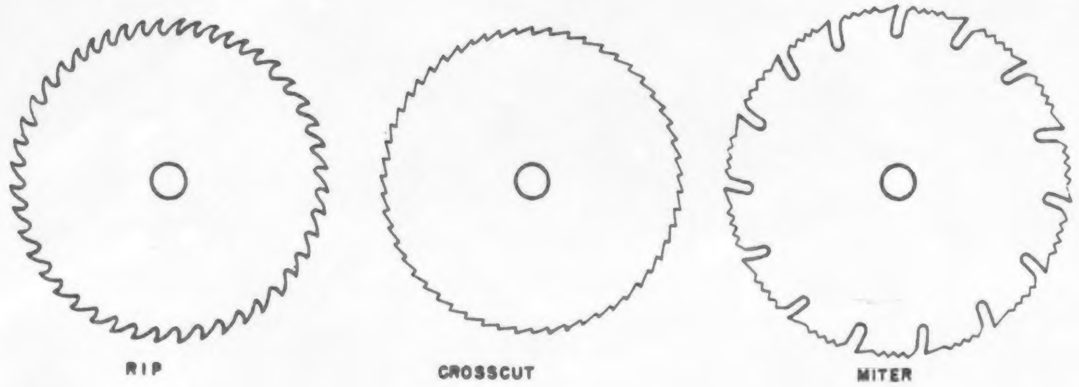


Figure 94. Circular saw blades.

crosscut guide in place and hold the work firmly against it as you push it into the saw.

11-7. Mitering is done in the same manner as crosscutting. However, when cutting miters, the work has a tendency to creep into the blade. To eliminate this, you can secure the work with a miter gauge extension with stops, or clamps. Special jigs can be made of wood to handle odd-shaped work. You should never attempt to make any cuts freehand.

11-8. Before setting up a dado head, you must replace the standard table slot insert with a dado insert to provide a wide slot. First, an outside blade is placed on the arbor; then the chippers are placed on and spaced evenly around the circumference of the head, as shown in figure 96. Avoid having the teeth of two or more chippers in a straight line across the head. Each swaged chipper end must be in a gullet of the adjacent outer blade. Then install the other blade. During grooving operations, the splitter cannot be used and must be removed.

11-9. Operations of the dado head are much the same as a standard saw; however, you must remember that the dado saw takes a bigger bite into the wood, and you must slowly push the work into the blades to prevent kickback.

11-10. **Cutoff Saw.** This machine is also referred to as a radial arm or overarm saw, as illustrated in figure 97. The saw can be raised or lowered with a handcrank.

11-11. On each end of the table, on which the saw is mounted, are rollers which make possible easy moving and sliding of large pieces of lumber as they are positioned for cutting. A saw of this type may use any of the three circular saw blades previously mentioned.

11-12. Over the blade is a guard that protects the operator from an exposed saw blade. It also channels the sawdust out through the opening to the right.

11-13. Crosscutting is done by placing the board flat on the table, with one edge held against the backrest. The saw blade is pulled evenly through the material. Remember to lower the saw only enough to cut through the board.

11-14. Ripsawing is much the same as with the table saw, except that the saw blade is above the work instead of below. When a board is being ripped, it is fed along the table, making sure the teeth of the blade revolve toward the operator.

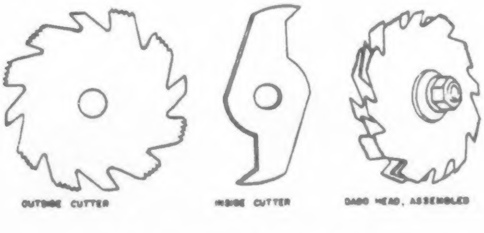


Figure 95. Dado heads.

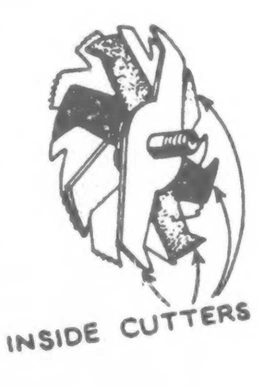


Figure 96. Placement of dado cutters.

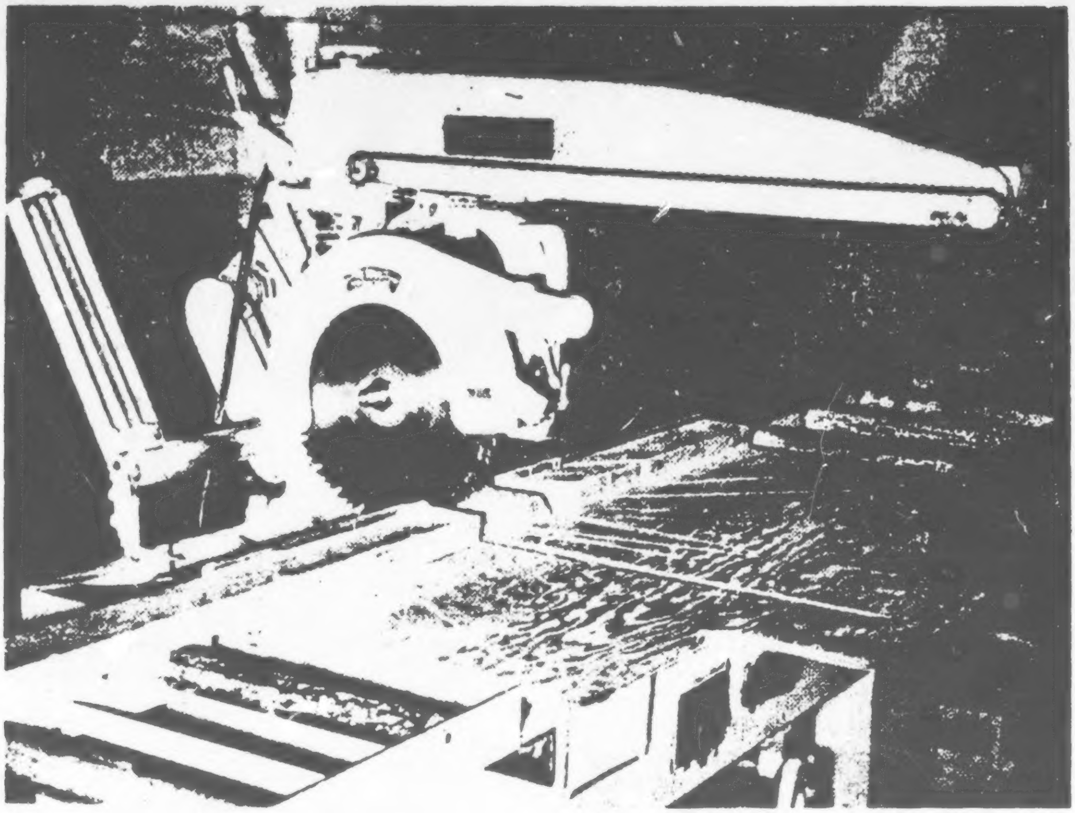


Figure 97. Overarm cutoff saw.

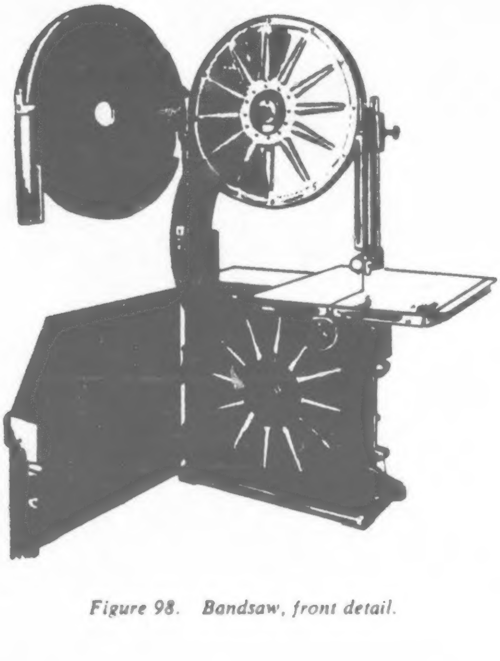


Figure 98. Bandsaw, front detail.

11-15. Bevels and angles are cut in much the same manner as crosscutting. The head of the saw can be rotated or tilted to various angles. The procedures outlined for crosscutting and ripping should be followed.

11-16. **Bandsaw.** The bandsaw is common in woodworking shops. Its chief use is cutting curved shapes. The machine consists of a cast iron frame and a large worktable. It has two large wheels, as shown in figure 98: one located above the table and one below, on which an endless steel saw blade revolves. A handwheel, located under the upper wheel, is used to adjust tension on the blade. For bevel sawing, the table can be tilted up to 45°. The width of the blade used depends on the radius of the curves to be cut. When the radius is short, a narrow blade is used. If the radius is long, use a wider and stronger blade. Saw guides, located above and below the table, hold the blade steady and prevent it from wobbling.

11-17. You should lower the guard to within ¼ inch of the material to be cut. Before turning on the machine, make sure the blade has the proper tension by adjusting the upper wheel (this holds the blade on the wheels). To prevent excessive coasting after the power has been turned off, the saw is equipped with a footbrake. The bottom surface of the stock must be flat when cutting on the bandsaw. If the piece wobbles the work will be inaccurate and the saw blade may kink. Always operate the machine by hand when making your adjustments. Guide the stock along the line marked on the face of the board holding it loosely and taking care not to crowd the saw. If cutting has to be stopped, let the saw cut through the waste instead of backing it out. If it is necessary to back the saw out of the cut, be sure to follow the exact cut originally made: otherwise, the saw blade may pull off the wheels. You should relieve the tension on the blade at the end of each workday.

11-18. **Jigsaw.** This machine cuts internal and external curves. An adjustable guide is provided for different thicknesses of material. When fitted with an appropriate blade, this machine may be used to cut wood, plywood, fiberboard, plastic, and soft metal. You operate the jigsaw in much the same manner as a bandsaw.

12. Surfacing Machines

12-1. We have discussed the basic power saws used in woodworking. Next, we will discuss surfacing machines. Each of these machines is designed to perform certain operations which will bring a rough piece of lumber to a smooth and true finish. The first of these is the surface planer.

12-2. **Planer.** The planer surfaces stock and reduces it to an exact desired thickness. In general, planers are classified as "single" or "double" surfacers, depending upon whether they surface one or two sides of a board in one operation. The double type is usually found in large planing mills, so we will confine the discussion to the single surfacer (see fig. 99).

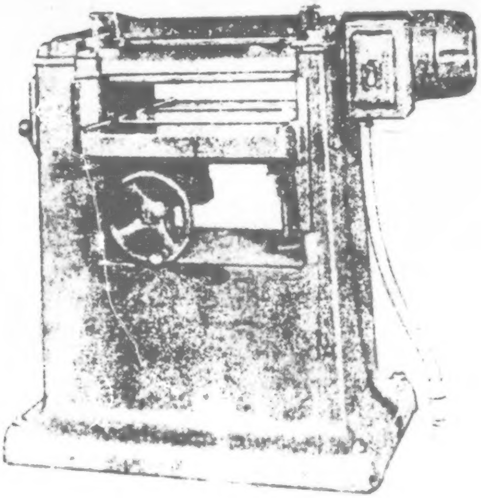


Figure 99. Single type planer.

12-3. The main parts of a planer lie together in a heavy frame which supports the other parts. The table consists of three parts: infeed table; center; and outfeed table, with smooth rollers on each side of the center section. The rollers help ease the lumber forward through the machine. You can raise or lower this unit with a handwheel to regulate the depth of a cut.

12-4. The cutterhead is usually a round cylinder which holds the cutting blades. On each side of the head are feed rollers which grip the stock and move it past the cutting head. On the outfeed side is a pressure bar which holds the stock firmly in place after it passes the cutters.

12-5. Before you use the planer, examine the stock and remove any foreign material which may nick the blades. Measure the thickness of the stock at the thickest point, and set the planer to remove the desired amount of stock at the thickest point. Maximum cut for average work is about $^{1}/_{16}$ inch. Place the stock on the table with the grain turned so that the knives will cut with the grain. Push the stock forward until it engages the infeed rollers; then withdraw your hands. Be sure the stock is long enough to reach over both infeed and outfeed rollers; otherwise, it may get caught in the center. If this happens you must stop the machine and lower the table in order to remove the stock. Never put your hand between the bed and the cutters while the machine is operating.

12-6. **Jointer.** This machine, used primarily for surfacing and edging, has several important parts: the front and rear tables, cutting head, fence, and safety guard. The rear table remains stationary for all but a few special operations, while the front table is adjustable and determines the depth at cut. The cutting head usually has three blades and rotates at high speed, while the fence is used to guide the board as it is pushed across the cutters. For beveling, the machine can be tilted as long as the safety guard is in place.

12-7. When operating a wood jointer, you must be extremely careful to keep your hands and body clear of the cutters. Long, loose sleeves should not be worn. The fence of the jointer should always be adjusted so that only enough of the cutters are exposed to plane the width of the board. The board to be planed is pressed evenly on the table and against the fence. It is important that the work not be hurried; instead you should push it evenly and firmly across the

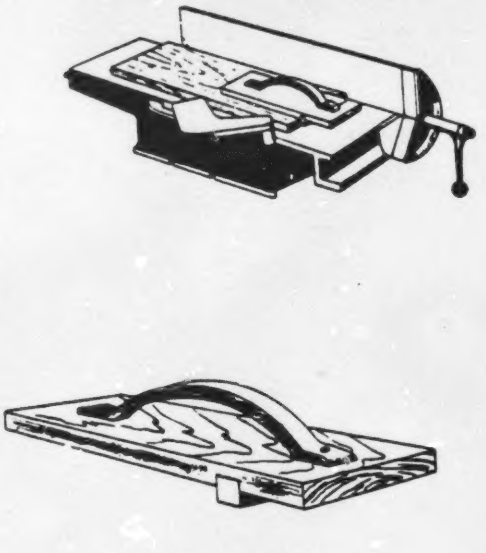


Figure 100. Push board.

cutter, using the same amount of pressure throughout. Pieces of lumber shorter than 12 inches should never be jointed on this machine. A pusher board should be used when planing wide flat work, as shown in figure 100.

12-8. Edging is an operation which straightens one edge of a piece of lumber. This straight edge provides a starting point for accurate ripping or for making butt joints. To make a straight edge, the straightest edge of the stock is placed on the front table; the flat side of the board is held firmly against the fence; and the entire piece is pushed over the cutter toward the rear table. This process is repeated until the board is perfectly flat.

12-9. Surfacing a rough piece of lumber on a jointer produces a true, flat, surfaced side. The procedure is the same as that for edging. As soon as the front part of the stock passes the cutterhead, hold it down firmly on the rear table. Since the rear table determines the plane of the cut, the stock must be held firmly against it to insure a true plane.

12-10. Rabbets are cut on a jointer by moving the fence over to the outer edge of the jointer to obtain the desired width of cut when the work is pressed against the fence. Bevel jointing is done by tilting the fence to the desired angle, as indicated by the fence angle pointer.

13. Sanding Machines

13-1. Mechanical sanders are used for smoothing and polishing surfaces. They are manufactured in many designs for different types of work; but the four general types are the disk, drum, belt, and spindle.

13-2. The disk sander consists of a circular metal plate with a sheet of abrasive glued to it. It is mounted on an arbor which is either stationary or portable; however, the stationary type is equipped with a table to support the work. The worktable is mounted even with the center of the disk and may be tilted for sanding beveled edges, angles, and tapers. The table usually has a miter gauge to guide the work being sanded. This sander is normally used for sanding edges of material. The sanding should be done on the half of the disk that revolves downward past the table. Move the work along the face of the disk to avoid burning the wood and ruining the sand or abrasive paper.

13-3. The drum sander is a large cylinder with an abrasive sheet attached. The cylinder is mounted in a large table and is used for sanding large, flat surfaces such as tabletops, etc.

13-4. Spindle sanders are circular in shape, but are much smaller and are used for smoothing curved shapes. Some machines are designed to move the spindle up and down as well as turn it. This type provides a larger sanding surface, and the abrasive will last longer.

13-5. The belt sander has two or more pulleys on which an endless belt runs. The sanding is done by holding a sanding block on the back side of the belt and pressing the abrasive side against the surface of the wood. Sanding belts are usually bought in the proper size for the machine on which they are used. It may, however, be necessary to join the ends to form a belt of the proper length. Splicing is very simple. It is made at a 45° angle across the belt. The abrasive is scraped off the end to be used as the backing for ⅜ inch to ¾ inch. The depth of removal of the abrasive will depend upon the size of the belt and the machine using the belt. The abrasive can be easily removed by dipping the end in hot water. After the abrasive is removed, a good glue is applied to the ends, and the ends are attached by placing one over the other and clamping them together. They must remain clamped together until completely dry.

14. Shaping Machinery

14-1. Among the wood-shaping machines are lathes, spindle shapers, and routers. These machines are explained in this section.

14-2. **Lathe.** The wood lathe is a machine tool for shaping wood by causing it to revolve between two centers while a sharp, cutting tool is held against it. This operation, called wood turning, shaves the wood, leaving a cylindrical shape. You will find the lathe very useful in

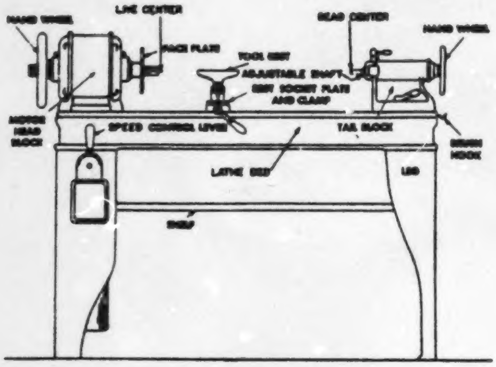

HAND WHEEL
LIVE CENTER
FACE PLATE
TOOL REST
ADJUSTABLE SHAFT
REST SOCKET PLATE AND CLAMP
DEAD CENTER
HAND WHEEL
MOTOR HEAD BLOCK
SPEED CONTROL LEVER
TAIL BLOCK
BRUSH HOOK
LATHE BED
LEG
SHELF

Figure 101. Wood turning lathe.

many lines of work, such as furniture and pattern making.

14-3. There are four main parts of a lathe: the headblock, tailblock, bed, and tool rest. The headblock consists of a motor, handwheel, and a hollow shaft, which holds the live center and which is threaded for the faceplate. The tailblock is a heavy, movable casting which is machined to fit the lathe bed. It is equipped with a clamp so that it can be secured to the lathe bed at any position. An adjustable shaft runs through the tailblock in alinement with the shaft in the headblock. The dead center fits into the tailblock shaft which is adjusted by turning the handwheel. All of these parts are illustrated in figure 101. The headstock is secured to the left end of the bed, whereas the tailstock can be clamped at any place along the bed. The tool rest is adjustable and fits into the tool rest socket, which can be clamped in any position along the lathe bed.

14-4. Lathe tools consists of gouges, skew chisels, round- and square-point chisels, parting tools, spear-point chisels, calipers, and dividers as illustrated in figure 102, details 1 through 8.

14-5. Gouges are round-nosed, concave chisels that are ground with an outside bevel. They

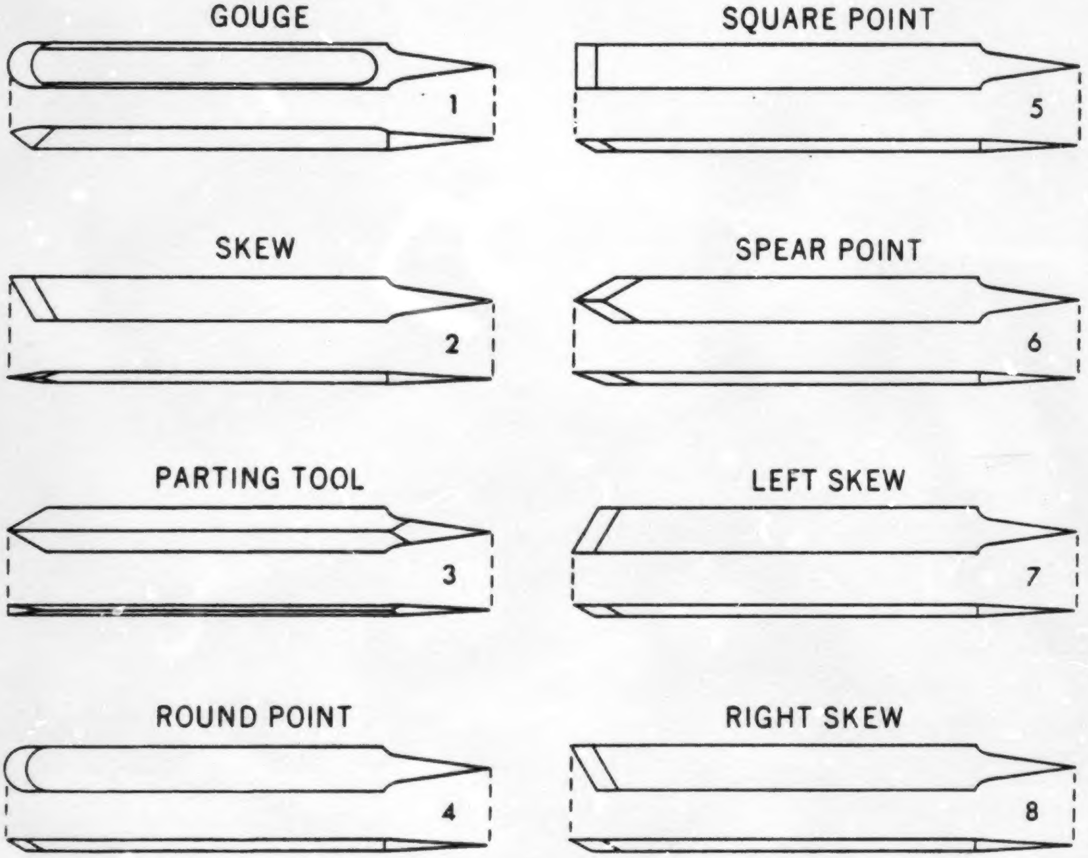

GOUGE
1
SQUARE POINT
5
SKEW
2
SPEAR POINT
6
PARTING TOOL
3
LEFT SKEW
7
ROUND POINT
4
RIGHT SKEW
8

Figure 102. Lathe chisels.

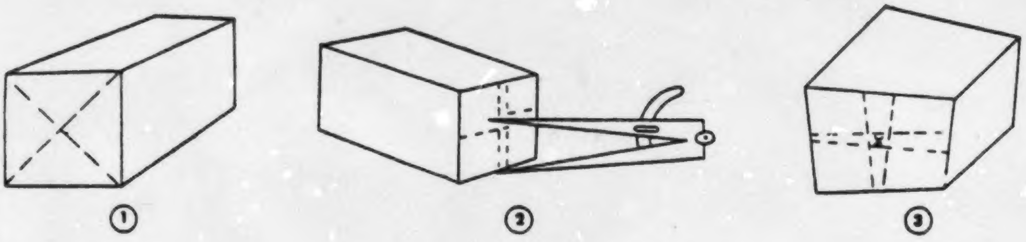


Figure 103. Spindle turning.

are used for making rough cuts, recesses, and coves. Gouges vary in size from ¼ to 2 inches in width. A gouge is illustrated in detail 1.

14-6. Skew chisels, shown in detail 2, are double-bevel, flat chisels with the cutting edge ground on an angle. They are used to make smooth cuts on wood cylinders, to square shoulder cuts, and to make bead and V cuts. These chisels are illustrated in details 7 and 8.

14-7. Parting tools, used for depth cuts (recesses and grooves) where gouges or skew chisels cannot be used, range in size from ½ to ¾ inches. The parting tool is illustrated in detail 3.

14-8. Round-point chisels are used chiefly on faceplate turnings, concave recesses, and coves. The round-point chisel is beveled on one side, as shown in detail 4.

14-9. Square-point chisels, used for smoothing convex or flat surfaces in faceplate turning, range in size from ½ to ¾ inches. The square-point chisel is beveled on one side, as illustrated in detail 5.

14-10. Spear-point chisels, as illustrated in detail 6, are used to finish insides of recesses and square corners.

14-11. Calipers and dividers are used together with rulers to measure, gauge, and mark dimensions for lathe work. For fine lathe work, it is essential to keep a well-sharpened set of lathe tools.

14-12. Spindle turning is performed on stock that is held between the live center of the headstock and the dead center in the tailstock. You must center mark the stock before it is put in the lathe. If the stock is square, diagonals can be drawn from corner to corner, as shown in detail 1 of figure 103. If the stock is not square, a pair of dividers can be used to estimate the approximate center of the stock, as illustrated in details 2 and 3 of figure 103.

14-13. If the wood is soft, the live center can be driven into the stock; however, if the wood is hard, saw kerfs must be made along the diagonals and a small hole bored in each end. A wooden mallet is always used to drive the live center into the wood. With the live center placed in the headstock and with the wood in place against the spur of the live center, the tailstock is set into position so that the dead center is within ¼ inch of the wood to be turned. Then clamp the tailstock in place and force the point of the dead center into the wood with the handwheel. Now back it off slightly and the spindle is locked. Remember to place oil or soap in the dead center to prevent the wood from burning while turning at high speed.

14-14. The tool rest is adjusted so that it is parallel to and about ⅛ inch from the outer edge of the stock, as shown in figure 104. The height of the tool rest will vary with the size of the

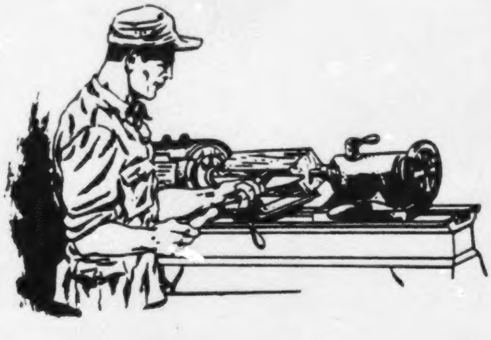


Figure 104. Using the tool rest.

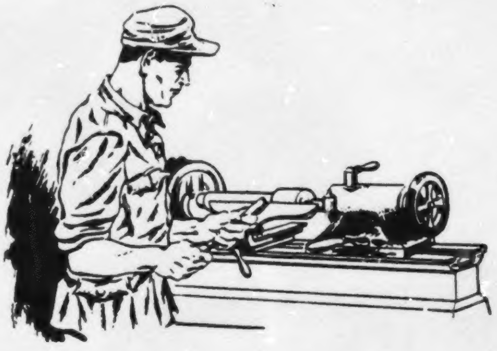
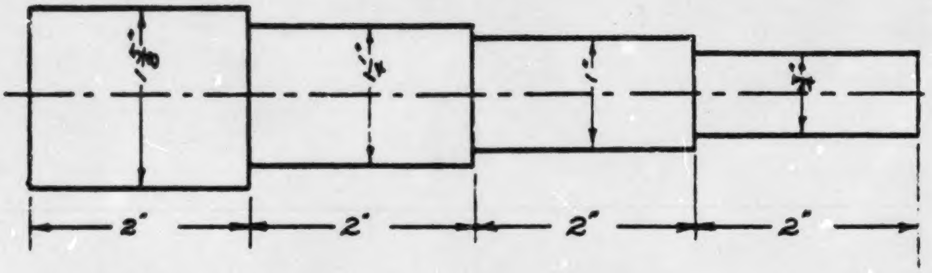
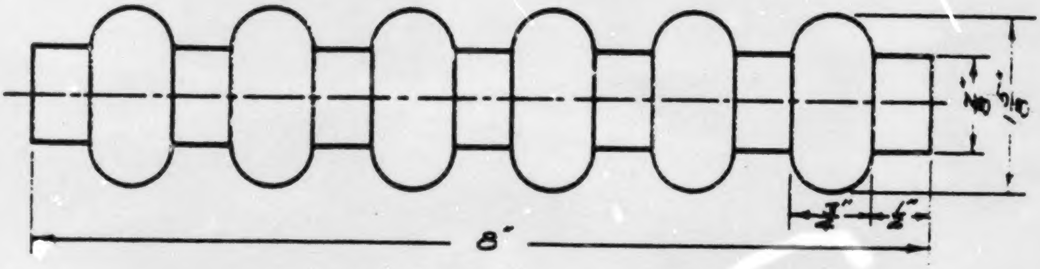


Figure 105. Using a skew chisel.

Shoulder Cuts.
Scale 3/4" = 1"


1 5/8
1 1/4
1
3/4
2"
2"
2"
2"

Convex Cuts.
Scale 3/4" = 1"


7/8
1 5/8
3/4"
1/2"
8"

Taper Cuts.
Scale 3/4" = 1."

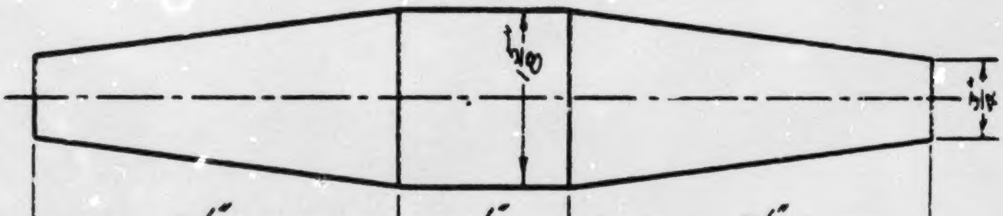

1 5/8
3/4
3 1/4"
1 1/2"
3 1/4"
8"

Figure 106.

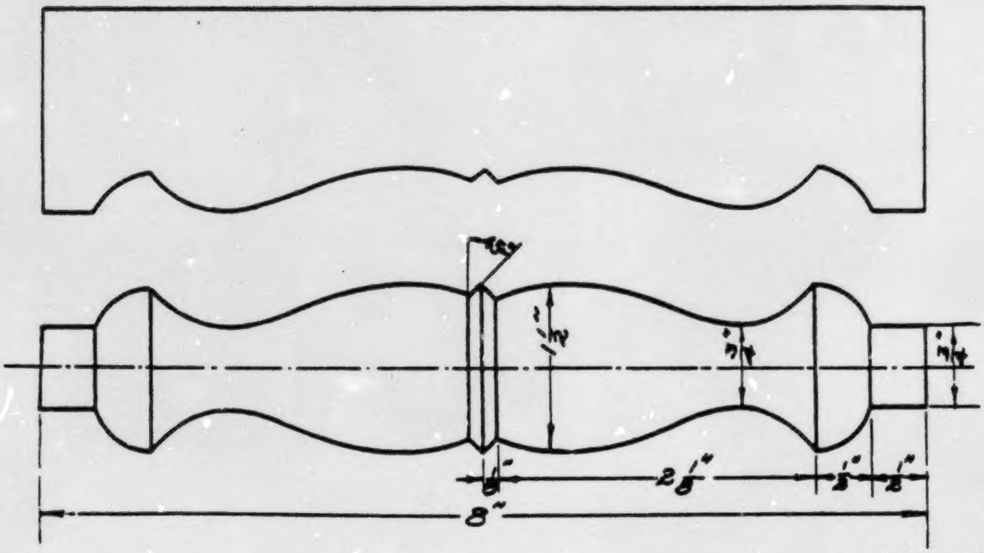


Figure 107. Template.

stock. Generally, however, it is from 1/8 to 1/4 inch above the horizontal centerline. It must be readjusted as the stock is turned, but never while the lathe is in motion.

14-15. A large gouge is used to reduce square stock to a cylinder. Steady the gouge against the tool rest with one hand while holding the gouge firmly, but not rigidly, with the other. Bring the gouge against the work, making a shearing cut with the side of the gouge. The rough dimensions should be set about 1/8 inch over the finished dimension.

14-16. After the stock has been reduced to a cylinder and to its approximate size, the skew chisel is then used for smoothing cuts, as illustrated in figure 105. These various cuts are illustrated in figure 106. When using the skew chisel, place the chisel on the tool rest before bringing it into contact with the wood.

14-17. When you make duplicate turnings, errors may result from inaccurate measurements of lengths or diameters and from variations in long, curved surfaces. To overcome this, you can use a template. A template is a full-sized pattern cut from any thin, stiff material. Each curve, head, or cove of the design is marked on the template to the correct dimensions. The template is then carefully cut out on the bandsaw. The outside piece—which reflects the contour and the various diameters of fine turning—is the template. Stop the lathe occasionally and compare the turning with the template, as illustrated in figure 107.

14-18. Another type of lathe work is known as faceplate turning. This is done on a metal disk, and you must remove the live center from the headstock shaft before you do this type of work. The metal faceplate is screwed onto the shaft of the headstock. Before securing the wood to the faceplate, surface one side of the wood and then place it against the faceplate. A circle or hexagon, slightly larger than the desired diameter of the turning, is then cut from the wood. This piece is then fastened to the faceplate with flathead wood screws, making sure the faceplate is centered on the stock. The tool rest should be kept as close to the stock as possible, regardless of the angle it may be set. It should be adjusted so that when the tools are placed on the tool rest, their cutting points will be at the horizontal centerline of the stock, as illustrated in figure 108.

14-19. The same tools and techniques are used for faceplate turning as for spindle turning.

14-20. To finish a lathe turning, press the sandpaper lightly against the work while the lathe is running at a medium speed. It is important to move the sandpaper from side to side to avoid scratches. Polishing is done by using a mixture of shellac, alcohol, and linseed oil. In this process, the shellac fills the pores of the wood; the alcohol dilutes the shellac; then the linseed oil distributes the shellac evenly and prevents the polishing cloth from sticking to the work.

14-21. **Spindle Wood Shaper.** The spindle shaper is used to add decorative details, such as moldings, grooves, flutes, and beads to wood. It

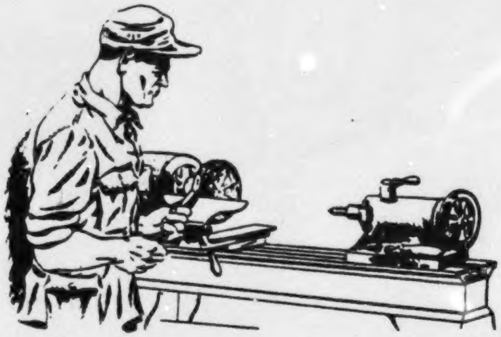


Figure 108. Position of tool rest for faceplate turning.

consists of a cast frame which supports a machined table, vertical spindle, motor, and various controls.

14-22. There are two types of cutters that can be used with the spindle shaper. One is a solid headcutter which consists of a solid disk of steel with three blades. The desired molding shapes are milled on the three blades, as illustrated in figure 109. The center of the cutter is drilled to fit over the spindle and the spindle nut keeps the cutter tightly in place.

14-23. The other type, the flat knife cutter, is made from two flat pieces of steel. The top and bottom edges are tapered to fit the grooved collars, as illustrated in figure 109. These cutters can be ground to any desired shape; however, both cutters must be of the same weight and balance, and identical in shape on the cutting edges. They must also be the same height so that they fit tightly between the collars. The cutters are held tightly in place by screwing the spindle nut securely against the top collar. An adjustment is provided to raise and lower the spindle to accommodate cuts of different thicknesses, and there is a clamp to lock the spindle in place.

14-24. The shaping operation for straight-edged stock is simplified by using a fence which can be adjusted in much the same manner as the table of the jointer. The opening between the two faces of the fence should be just large enough to clear the cutter.

14-25. The holddown and holding fingers, located on the holding arm, can also be adjusted. You must always adjust them to hold the work piece firmly against the fence and down on the table as it is being fed against the rotation of the cutter.

14-26. To shape stock with curved edges, you must remove the fence from the table. Then, one or more collars are mounted on the spindle with the cutter, serving as a stop against which the work can be pressed. You can adjust the depth of each cut by adjusting the distance which the knives project beyond the collars. As the stock is pushed against the cutter, a great amount of kickback is encountered. To avoid this, a steel guidepost is inserted in one of the holes in the table and the work is firmly pressed against it. It can then be safety fed to the cutter to start a cut without a kickback. As soon as the cut is started, swing the work away from the post and continue to press it against the collar.

14-27. We have discussed the basic fundamentals of the shaper. The setups are too numerous to go into at this time. However, we should mention a few rules to follow when operating this machine:

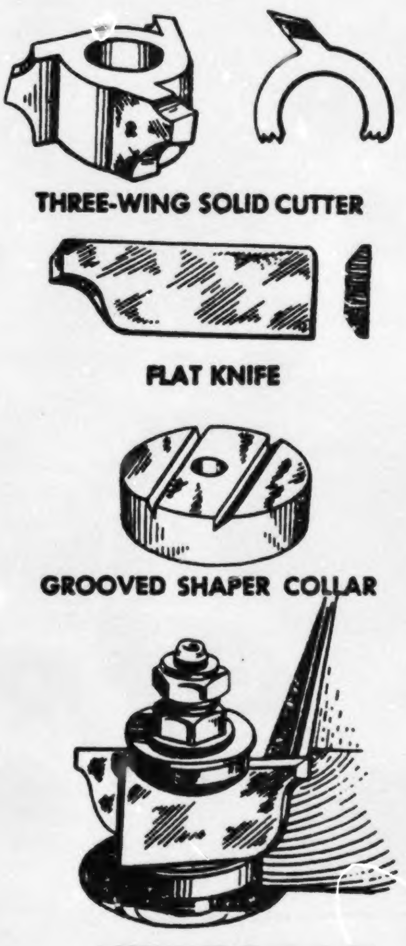


Figure 109. Shaper cutters.

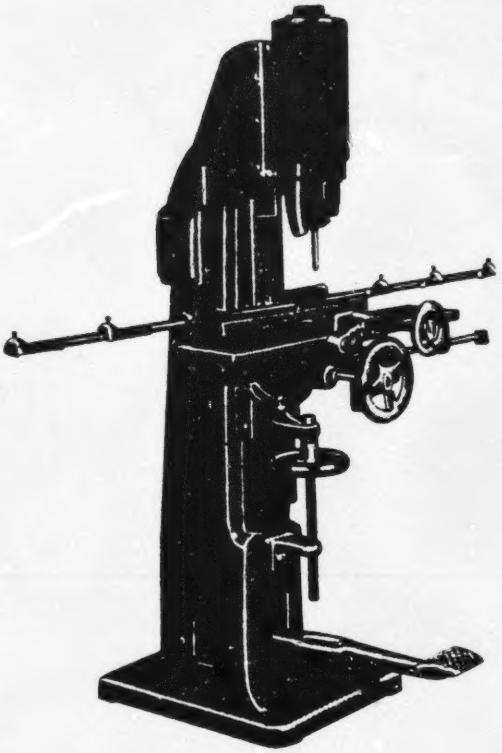


Figure 110. Hollow chisel mortiser.

- Always check to see that the cutters are the same size and weight.
- Always feed the stock against the turn of the cutter blades.
- Be sure the stock is flat and rests firmly on the shaper table.
- Don't feed the stock into the cutters too fast. Use a firm, steady feed.
- Be sure you have been checked out and understand the machine fully before you attempt to use the shaper by yourself.

14-28. Now, we will discuss a machine that performs work similar to that done by the shaper. It is called a router.

14-29. The router is used for mortising, rabbeting, dovetail grooving, edge shaping, and many other jobs.

14-30. The cutter bits, obtainable in different widths and shapes, are held in place by a screw-type chuck. The machine is moved over the work by hand, either freehand or by use of special guides and templates. The depth of cut can be adjusted by rotating the frame around the threads on the exterior of the motor.

15. Drilling Machines

15-1. Up to this point, we have examined the power machines that will saw, smooth, and shape lumber. Now, we will discuss the power machines used to drill various sizes and shapes of holes in lumber. The first of these is the mortiser.

15-2. **Mortiser.** The hollow chisel mortiser, as illustrated in figure 110, is designed to cut mortises in wood. The cutting tool consists of a bit which revolves inside a square, hollow chisel, as illustrated in figure 111.

15-3. This handy tool consists of a cast frame which supports the rest of the machine. The head assembly is mounted high in the front of the frame and consists of the motor, chuck, and bit. The foot treadle near the floor lowers and raises the cutting bit. The spacing gauge, with its stops, is located above the fence and is used to regulate the length and spacing of mortises. When you are using a mortiser of this type, it should be secured firmly to the floor.

15-4. **Operation of the Mortiser.** Place the cutting tool, shown in figure 111, in the chuck directly under the motor and secure it in place with a setscrew. Set the bit to project about

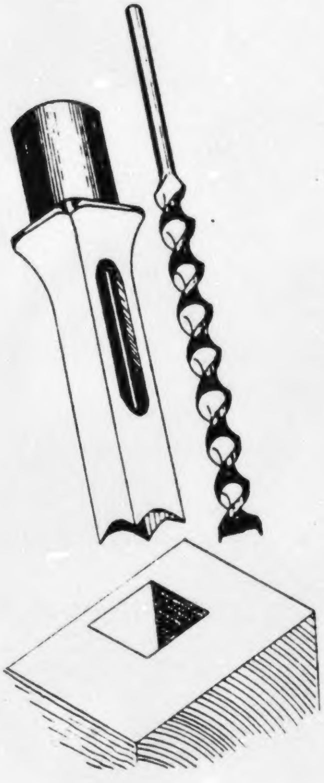


Figure 111. Mortiser cutting tool

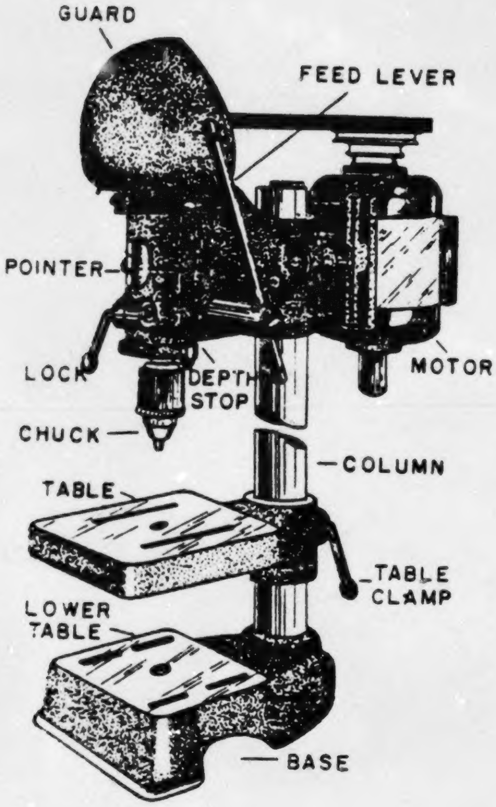


Figure 112. Bench-mounted drill press.

⅛ inch below the hollow chisel. The size of these bits and chisels varies from ¼ to ¾ inches. Now, force the bit and chisel into the wood with the foot treadle. While the bit revolves inside the hollow chisel and cuts a round hole, the hollow chisel, which does not revolve, cuts the sharp corners to complete a square cut. A rectangular mortise can be made by making square cuts side by side. You can do this by moving the table with the handwheel.

15-5. The mortiser has no special guards. However, when you operate a hollow chisel mortiser, use the utmost care and make sure that all the adjustments are made correctly and that all the clamping devices are secured.

15-6. **Drill Press.** The main parts of a drill press (as illustrated in fig. 112) are: a polished steel column that is fastened to a cast iron base, a table for holding the work, and a head assembly which includes the motor, feed lever, guard, pointer, lock, chuck, and depth stop. With this tool, the worktable and head assembly may be moved up or down on the column and clamped.

15-7. The head of the drill press has a boring spindle which has a cone-shaped pulley, mounted at the top. To change the speed (rpm) of the drill, an adjustment is made to the core pulleys. A drill press is designed basically for drilling holes in all types of material; however, special spindles with threaded ends of various sizes are available for holding shaper cutters, planers, sanders, and grinders.

15-8. The table has a smooth working surface which is slotted to facilitate clamping the work in place. It is adjustable for height and may be tilted to various angles. A hole is provided in the center of the table to allow the bit to pass through.

15-9. When you are using a shaping attachment on the drill press, the table and head assembly are reversed on the column with the head assembly turned upside down. The spindle passes through the hole in the table to receive the shaper cutters.

15-10. The mortising attachment, as illus-

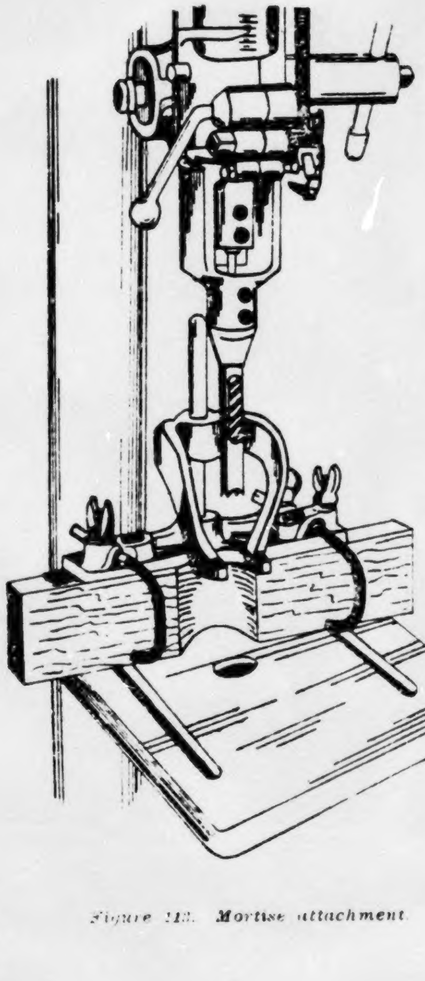


Figure 113. Mortise attachment.

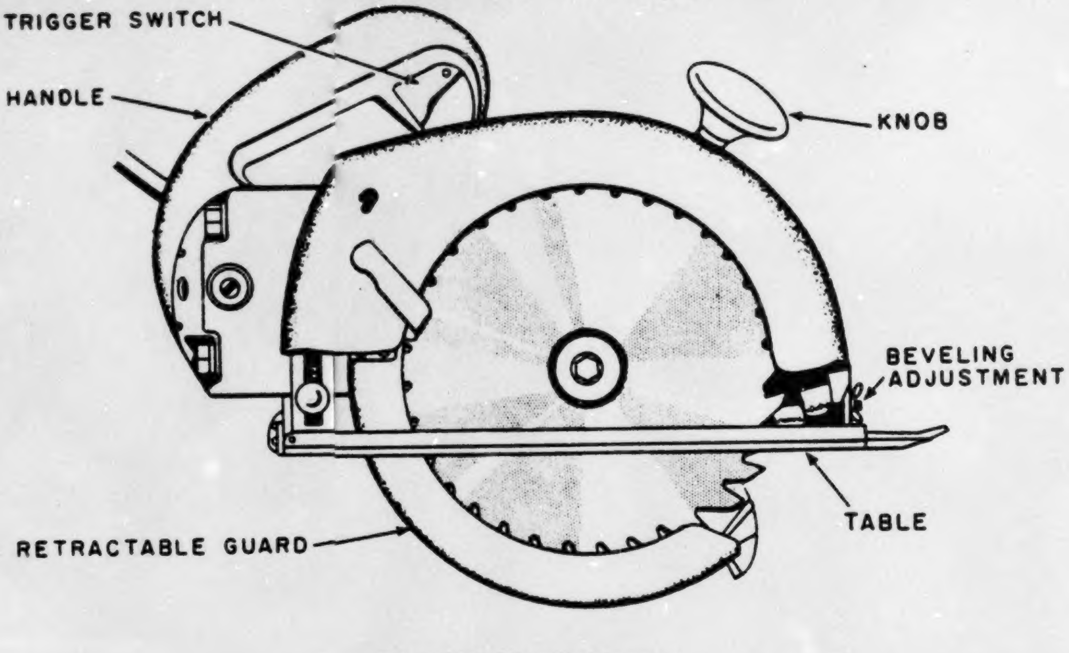


Figure 114. Portable power saw.

trated in figure 113, includes a wooden fence, holddown brackets, and chisel holder. This attachment converts the drill pres into an accurate mortising machine.

16. Portable Power Tools

16-1. As a carpenter, you w ll have to know how to operate portable power ools, such as the power saw, electric sander, e ectric drill, and the electric planer. When electr c power is available at the work site, these to ls can make the job much easier and save tim They are als used in the carpentry shop for work that is not appropriate for the bigger mac ines.

16-2. **Portable Power Saw.** T e portable power handsaw, as shown in figure 14, is a circular saw that can be held in the and to perform ordinary sawing operations. T e blade is protected by a retractable guard a all times except when actually sawing. The depth of the cut can be varied by adjusting the table of the saw to the proper depth of the blade exposed below the table. The table is locked in place with a thumbscrew. The table can also be adjusted to furnish you with the desired angle of cut necessary for your board. The table is set at the desired angle and is held in place by a thumbscrew. The blades for this saw come in sizes of 6 to 8 inches. Special blades for cutting masonry or sheet metal may be obtained.

16-3. **Oscillating Sander.** This sander, as shown in figure 115, is a machine to which a sheet of abrasive is clamped. The sheet is held in place by a spring-tension bar, located in the front and rear of the backing plate. This type of

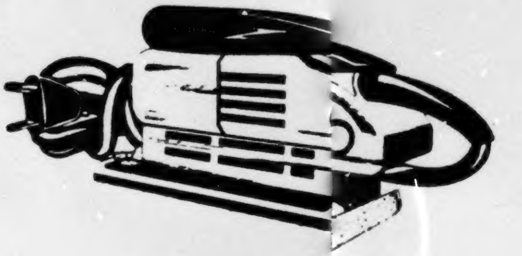


Figure 115. Oscillating sande

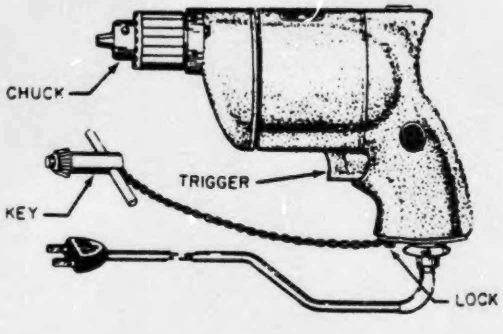


Figure 116. Portable drill.

sander is operated in a backward and forward motion and can be moved across or with the grain of the wood without leaving swirl marks. It also can be used with a felt pad to rub down finishes if a high gloss is desired.

16-4. **Portable Drill.** The electric hand drill is a portable tool that can save you many hours of labor. They come in a variety of sizes, usually ¼ to ½ inch, and can be used to drill holes in metal, wood, and masonry. Straight-shanked spurless auger bits and sanding discs are some of the attachments that can be used on the portable drill. This drill is illustrated in figure 116.

16-5. **Portable Planer.** Small portable planers are sometimes taken to the work site where there is a considerable amount of planing to be done in kitchen cabinet work. This tool will give you a fast, smooth, and accurate job in your edge-planing work. It has a long shoe for easy starting of cuts and for stability in your planing operation; it has a front and rear depth adjustment. It also adjusts for your beveling needs. Use both hands in the operation of this tool for the best results. You will find that in most cases extensive planing is done in the carpentry shop.

99

Ladders and Scaffolds

A NEWS ITEM in the local paper tells of a carpenter breaking his leg in a fall while working on a two-story building. The article goes on to tell of his falling when the ladder he was working on slipped or that the scaffolding gave way, letting him fall to the ground. Do not let this happen to you. Know how to choose the right ladder and how to place it in the proper position for your job. Know also how to build the proper scaffolding to permit you to do your job safely.

2. Construction jobs may require the use of ladders or scaffolds to reach high places and make the work easier. The most common hazard in the use of ladders and scaffolds is the possibility of falling from them. In this chapter, we will tell you about some of the more common types of ladders and scaffolds and also how to use them safely.

17. Ladders

17-1. Several types of ladders are available to you for construction work. They are straight, extension, and stepladders. The good ones are made of seasoned wood or substantial metal and also conform to the accepted industry code and Federal regulations. The rungs of good ladders are strong enough to hold a weight of approximately 500 pounds.

17-2. **Straight Ladders.** Straight ladders that are not self-supporting should equipped with nonskid bases (safety shoes). When these ladders are not equipped with safety shoes, you can make them safe for use by placing safety hooks at their tops, and securing them to nearby supports.

17-3. To raise a straight ladder, you place it on the ground and at right angles to the wall which you intend to scale. The top of the ladder is placed toward the wall. Place one man at the foot of the ladder with his feet holding the side rails in position to prevent the ladder from kicking backwards. You and another man grasp the ladder part way from the top and raise it from the ground. As the ladder is raised, it is "walked" toward the building and you keep moving toward the foot of the ladder, raising and grasping new holds until the ladder is in position. Short and light ladders may be raised by one man or by a different method. The size, length, and weight of the ladder govern the number of men required to raise it.

17-4. When the ladder is in final position, check the bottom of the ladder to make certain it has a firm footing. If the ground is soft, or if the ladder does not rest squarely on the ground with both bottom legs, you can place a board under the feet. If the bottom of the ladder has antislip surfaces, you clean these surfaces before placing the ladder in position. The ladder should be placed at a safe angle against the wall.

17-5. **Extension Ladders.** In selecting an extension ladder for a particular job, you should remember that this type of ladder is designated by its nominal length, which is the sum of the lengths of the sections. The usable length of the ladder is 3 to 10 feet less than the nominal length because of the overlap of the sections. Pulleys and ropes are provided for adjusting the length of these ladders. When you adjust their length, the sections must overlap at least 3 feet for a 38-foot extension; 4 feet up to a 45-foot extension; and 5 feet for any extension over 45 feet. You must never use a ladder extended beyond 60 feet.

17-6. Extension ladders should be equipped with antislip (nonslip) bases (spikes or safety shoes) and spring-loaded rung locks with metal shackles. Occasionally sections of an extension ladder are used separately. If you do this, you must turn the upper section of the ladder upside down so that the missing rung at the lock is at the top of the ladder where it is less likely to cause an accident.

17-7. You position and raise the extension ladder in the same manner as you do the straight ladder. When the lower section of this ladder is nearly in the final position, you pull the ladder away from the building until it stands nearly vertical but leans slightly toward the building. While the ladder is held in this position, raise the extension section by pulling down on the rope fastened to the extension section. Do not try to raise the extension section to its fullest extension on the first pull. You should pull up the extension section in easy stages, checking the height of the ladder at intervals in order to determine the correct height. You are required to have at least two men to move or raise an extension ladder. Extension ladders containing more than three sections will not be used together as a single ladder.

17-8. **Stepladders.** All stepladders are self-supporting and are used on flat surfaces to insure solid footing. When open, the steps should be horizontal. All stepladders should be equipped with an automatic spreader or locking device to keep them open. Under no circumstances are you to use stepladders as substitutes for workstands. No stepladder higher than 20 feet will be used on any of your jobs.

17-9. Keep the locking device or automatic spreader fully opened and locked when you use the stepladder. The locking device or automatic spreader is provided on each stepladder. Do not use stepladders when you can determine that other devices (platform or ladders) are more practical and safer.

17-10. Carefully inspect all new ladders to make certain that they conform to purchase order specifications or that they are of a type known to be acceptable for military use. Before you use them, inspect both new and used ladders for:

- Loose or broken rungs.
- Broken, split, or cracked rails.
- Loose nails, screws, or bolts.
- Missing, broken, or damaged safety shoes.
- Condition of spreaders and hinges on stepladders.
- Defective locks on extension ladders.
- Condition of ropes and sheaves on extension ladders.
- General serviceability.

17-11. In use, portable or extension ladders should be placed with the foot of the upright ladder approximately one-quarter of its length away from the building, as shown in figure 117. You are probably asking yourself how you can tell the length of the ladder needed for the job to satisfy the ladder placement rule. You will probably know the height that you want to reach or the point of contact with the wall or support. A rule of thumb is to add one foot to the height of the known point of contact on the vertical line of support up to 30 feet. Over 30 feet and up to 60 feet, add 2 feet to the height of the known point of contact on the vertical line of support. For example, you know the height of the point of contact is 18 feet and adding 1 foot gives you 19 feet. Therefore, you know that you will need a ladder of at least 19 feet in length to make your correct ladder placement.

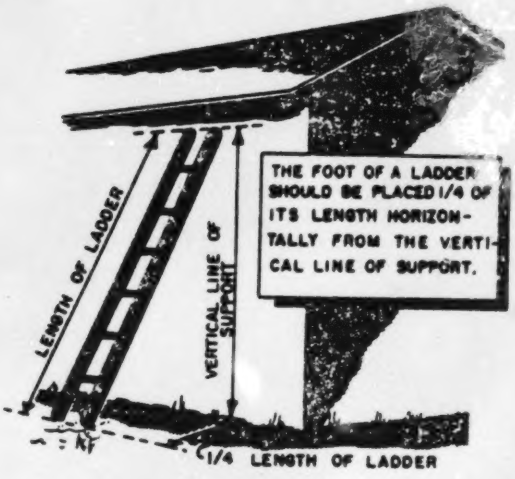

LENGTH OF LADDER
VERTICAL LINE OF SUPPORT
THE FOOT OF A LADDER SHOULD BE PLACED 1/4 OF ITS LENGTH HORIZONTALLY FROM THE VERTICAL LINE OF SUPPORT.
1/4 LENGTH OF LADDER

Figure 117. Correct ladder placement.

17-12. Remember, place the ladder so that each side has secure footing, with solid objects set under the rails in soft ground. Never lean a ladder against loose or unsafe objects, nor use it in a horizontal position. When it is necessary to place a ladder against a window, secure a board across the rails so that the board will bear on both sides of the window frames. When ascending or descending a ladder, face the ladder and hold on to each side rail. You should work only on step or platform ladders when work requires the use of both hands. Your fixed or portable ladders should extend at least 30 inches above landings or platforms to facilitate safe climbing on and off. On most manufactured ladders, the distance from center to center of the rungs is 12 inches. This means that the third rung of the ladder from the top is near or above the platform landing.

17-13. When the security of a ladder is endangered by other activities, rope off the area around it, fasten it securely, and assign a man to steady the bottom. When using a ladder in front of doors which open toward it, block off the doors and route personnel to another exit. Never leave a ladder unattended for any length of time while it is place — take it down and lay it on the ground.

17-14. When working on a ladder, stand no higher than the third rung from the top, and do not attempt to reach beyond a normal arm's length. Also, if you need help to do the work, have your helper get another ladder—don't allow him on the ladder with you. One man at a time is enough on a ladder.

18. Scaffolds

18-1. Scaffolds of various types are used in construction, repair, and maintenance of buildings and other structures. It is practically impossible for a workman to do satisfactory work at a height greater than 5 feet above the level on which he stands. This work could apply to sheathing, trim, or finish to the outside; or it could apply to installing and finishing sheetrock on the ceilings and walls. In any case, this elevated work requires you to construct something to work on that will not be left as a permanent part of the completed building or structure—a scaffold. Therefore, you will need to build an arrangement of scaffolds to enable you to work efficiently and safely at heights of greater than 5 feet.

18-2. Before we begin to discuss the use of scaffolds, let's keep one thing in mind, and that's safety. In your work as a carpenter, there is nothing more dangerous than a scaffold that has been improperly constructed or incorrectly set up. Serious and fatal accidents occur with the incorrect usage of scaffolds. Everyone engaged in construction must realize that human lives depend upon the proper placement and the proper construction of scaffolds, and the correct setting-up of swing stages.

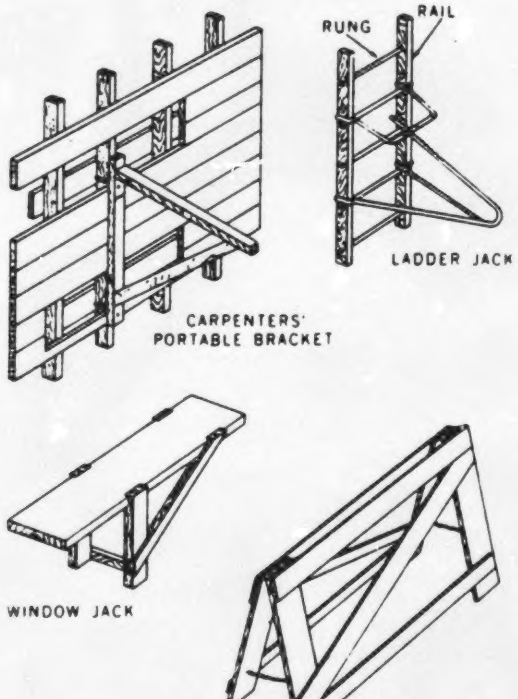


Figure 118. Types of scaffolds.

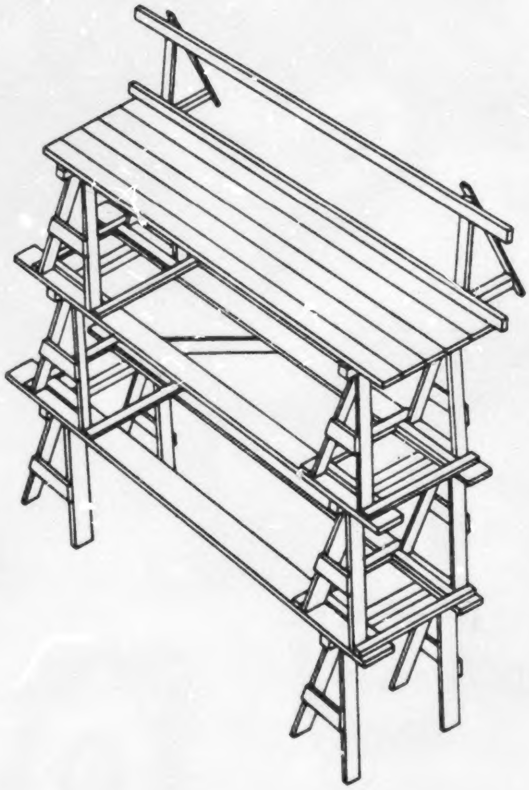


Figure 119. Maximum height of horse scaffold.

18-3. The many types of scaffolds in common use include single pole (where the wall supports one side), double or independent pole (where the scaffold stands by itself), tubular metal scaffold (commercially manufactured), suspended, window jack, ladder jack, and horse scaffolds. Some of these are shown in figure 118. Figure 119 illustrates how a horse scaffold is set up. The maximum height that it may be is three tiers. Notice the locking cross boards to prevent the horses from slipping.

18-4. **Double Upright Scaffold.** This type of scaffold is built to provide great strength and stability. The double upright (pole) scaffold is used in construction work where it is undesirable or impossible to support any of the platform load

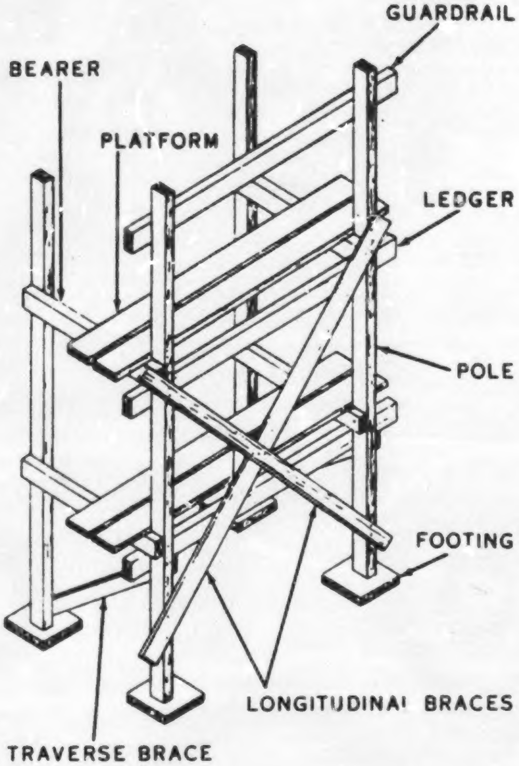


Figure 120. Double upright scaffold.

by the framework. This scaffold is illustrated in figure 120, with the names of all the parts.

18-5. When building a double upright scaffold, you must consider the purpose for which it is being constructed. A scaffold used by masons, which must support considerable material loads plus the workers, must be constructed of heavier materials than one used by painters. For light work, the uprights are frequently made of 2- x 4-inch material. Where heavier loads are to be supported, 4- x 4-inch or heavier upright members are used. The spacing of the uprights depends upon the weight supported by the platform. Ordinarily, the spacing is from 7 to 10 feet on centers. The width of the scaffold depends upon the type of work being done. For all practical purposes, the two lines of uprights should be spaced to permit five 2- x 10-inch planks to be placed between them. To correctly build a double upright scaffold, use the items described below.

18-6. *Ledgers.* A ledger is a horizontal piece fastened to the vertical uprights. Ledgers serve as stiffeners for the uprights, supports for the bearers, and form an essential part of the lengthwise bracing. The ledgers should be placed on the inside of the uprights and nailed to every upright.

18-7. *Bearers or crosspieces.* Bearers consist of boards nailed on the side of the uprights. They support the platform planks, and rest directly on the ledgers. Standard material for bearers is 2- x 6-inch material.

18-8. *Platform.* The platform is usually constructed to accommodate five 2- x 10-inch planks. The planks are placed flat and as close together as possible. It is not necessary to secure these planks, but they should be arranged to prevent the planks from kicking up when someone steps near the end.

18-9. *Longitudinal braces.* Longitudinal braces are used to keep the scaffold from collapsing under a load. These braces usually consist of diagonal pieces of 1- x 6-inch material, nailed to the outside surfaces of the uprights.

18-10. *Traverse braces.* These braces should run in one direction only. The method of bracing is strong and will not hinder the passage of workers.

18-11. **Single Upright Scaffold.** The single upright scaffold is made with one row of uprights. This single row of uprights is on the outside of the scaffold which is supported on the inner side by the structure. One end of the bearer is nailed to the upright and the other to cleats, as illustrated in figure 121. The single upright scaffold is similar to the double upright scaffold.

18-12. **Portable Supported Scaffold.** The portable scaffold is used to repair or decorate ceil-

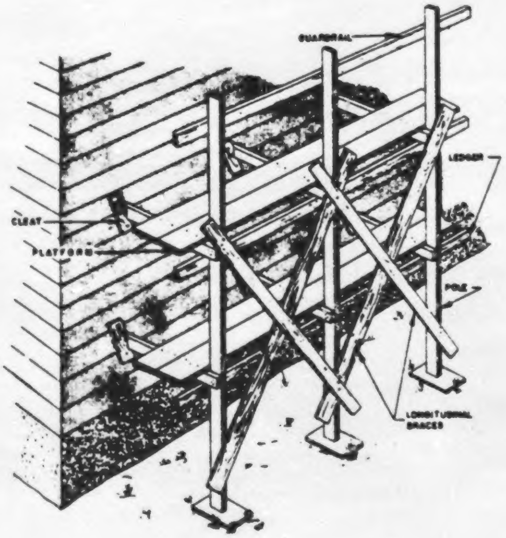


Figure 121. Single upright scaffold.

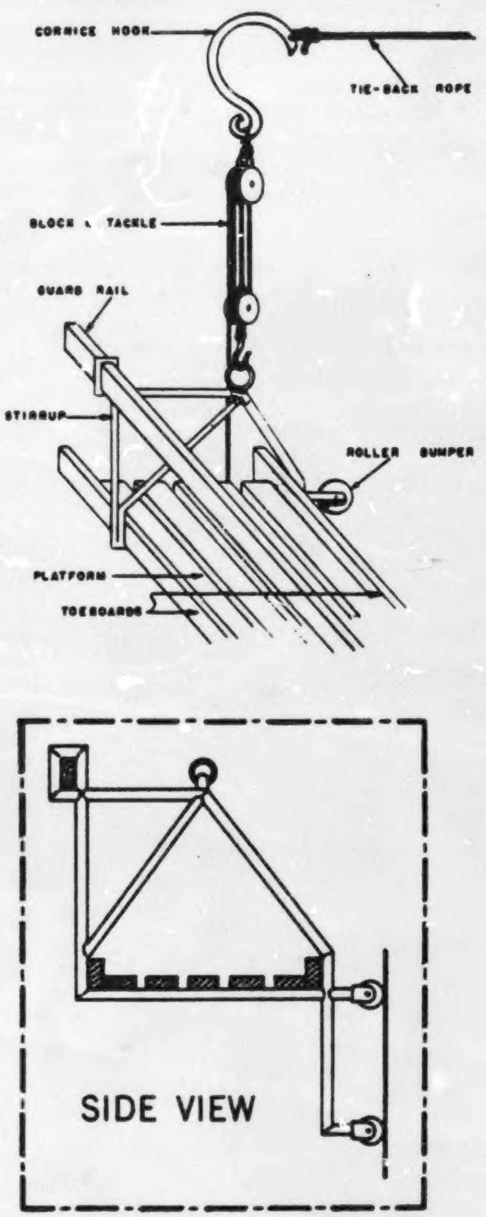


Figure 122. Swing stage scaffold.

ings of great heights. The construction of the scaffold is similar to that of the double upright type. Sometimes, casters are used on the portable scaffold to make it easy to move. Casters must be locked with the braking device before the scaffold is used.

18-13. **Adjustable Metal Scaffold.** This type of scaffold is made of lightweight, fireproof, tubular steel. For safe operation, this type of scaffold must be erected and dismantled according to the manufacturer's directions.

18-14. **Swing Stage Scaffold.** The swing stage is different from all other scaffolds. This type scaffold is used to reach the upper surfaces of structures by suspending a platform with rope or steel cable. A swing stage scaffold, as illustrated in figure 122, consists of cornice hooks, hoisting equipment, guardrails, stirrups, toeboards, and platforms.

18-15. *Cornice hooks.* Cornice hooks are sometimes referred to as roof hooks. They are large metal devices, resembling a fish hook, which hook securely over the top portion of the roof. The top of each hook is equipped with an eye to which the ends of tieback ropes are fastened. The other ends of the tieback ropes are secured to a chimney, solid pipe, or any other securely attached projection. Tieback ropes are used only for safety reasons.

18-16. *Hoisting equipment.* Hoisting equipment, referred to as block and tackle, is used to raise and lower the platform of a swing stage scaffold. This equipment consists of two double-pulley blocks and two single-pulley blocks. A double block is hooked into each lower eye of the cornice hook, and a single block is hooked into the eye of each metal stirrup supporting the platform.

18-17. Another type of hoisting equipment used to lower and raise swing stage scaffolds is the hoisting machine. Hoisting machines use steel cable instead of ordinary rope. The hoisting machine has a lock and brake, both of which are controlled by the worker. The lock and brake work in conjunction with each other to make the unit safe.

18-18. The swing stage stirrup is a metal unit that supports the platform and to which the lower tackle block is attached. There are usually two stirrups to a swing stage scaffold. Each stirrup is placed a short distance in from the end of the platform and has a roller bumper attached to its bottom. The purpose of the bumper is to keep the platform from marking or scratching the sides of the structure.

18-19. The guardrail is also an essential part of the swing stage scaffold. It is usually made from 2- x 4-inch material and is held in place by a special section of the stirrup. This arrangement places the guardrail about 40 inches above the platform. A small rope used to hoist the material may be attached to the guardrail.

18-20. The platform is the working area on which the workers stand. This platform is approximately 24 inches wide and 26 feet long and is made up of at least 2-inch planking. Toeboards, constructed of 2- x 4-inch material, run the full length of the platform.

18-21. **Scaffold Safety.** As with ladders, the most common hazard associated with scaffolds is the possibility of falling. Proper construction and use of scaffolds help immeasurably to prevent these falls. You should be familiar with the following precautions concerning the safe erection and use of scaffolds, especially if you work on scaffolds as part of your daily work.

18-22. Scaffold materials should be the best and free of any weakening defects. You should carefully inspect all scaffold materials before you use them to insure that they can support loads at least four times greater than the loads you expect to put on them. You should not use makeshift scaffolds under any circumstances, since support must be substantial. The following basic rules cover the erection of wood pole scaffolds:

- See that all pole uprights are plumb (straight up).
- When you splice poles, make certain that the square end of the upper pole rests flush on the square end of the lower pole. Securely splice the two ends together. Stagger pole splices to distribute stresses—don't splice them at the same level.
- Place poles on 2-inch blocks, large enough to spread loads and to prevent settling. Nail the ends of the poles to the blocks to prevent movement, and securely brace poles set on any surface other than blocks.
- Use supporting ledgers long enough to extend over the two pole spaces, overlapping each pole at least 4 inches. Splice ledgers at the poles, never between them.
- Leave the bottom ledgers in place as the platforms are built up to brace and stiffen the poles.
- Replace all split ledgers immediately. Don't leave a split ledger in place and simply renail it.
- When bottom platforms are more than 5 feet from the ground, provide ladders or runways for safe access. Place permanently secured ladders between all the working platforms of scaffolds.
- Provide sturdy guardrails and toeboards on all scaffolds. (Guardrails are placed 36 to 42 inches above the platforms.)

18-23. When placing a scaffold over personnel and equipment, completely inclose the spaces between the guardrails and toeboards. Use planks or other sturdy materials for overhead protection on scaffolds when work is being done above you. You should work on scaffolds during good weather, not during high winds or storms. Store only one day's supply of construction materials on the scaffolds. If you are unsuited to scaffold work for any reason, such as being unable to adjust to heights, you should not work on scaffolds.

18-24. You should keep the scaffolds as clean as possible at all times. Clean up paint spills immediately, and remove all tools, materials, and debris from them at the end of each day's work. Keep snow and ice from the scaffolds to prevent injuries resulting from slipping and falling.

18-25. Inspect the moving parts of a swinging or suspended scaffold at regular intervals for proper functioning. All parts of the swinging scaffold must be inspected daily for defects. Supporting ropes will be of at least ¾-inch, first-grade manila, or equivalent wire cables. The following are some other basic safety rules to be observed when you are using a swinging or suspended scaffold:

- Never store construction materials on these scaffolds.
- Never have more than two men working on the scaffold at any one time.
- Test a scaffold prior to use by raising it 12 inches of the ground and loading it with weights at least four times as great as the weight placed on it in actual use.
- Require all personnel working on the scaffolds to wear lifelines tied to safety belts to prevent injury should they accidentally slip and fall.
- Never tie two scaffolds together with bridging.
- Lash the platform of the scaffold to the building to prevent swaying.
- You or your workmen never leave the scaffold until it has been lowered to the ground.
- Your platform is made up of at least three 2- x 10-inch planks.

18-26. When you are working on a swinging scaffold and you are wearing your safety belt tied to a lifeline, the lifeline will be only long enough to permit you to reach your work. Your attention to the length of the lifeline will prevent you from falling any great distance if you should slip or fall from the scaffold.

EXAMINATION

ARMY CORRESPONDENCE COURSE • ENGINEER SUBCOURSE 531-0

CARPENTRY I (TOOLS AND EQUIPMENT)

CREDIT HOURS ------------------------2

TEXT ASSIGNMENT ----------------------Review all previous lessons.

EXERCISES

Requirement. Each multiple-choice exercise in this examination has **one** best answer. Select your answer, then, on the answer card, punch through the letter that indicates your choice.

1. What are the general classes of architectural drawings?

a. primary and working
b. descriptive and directive
c. instructional and specific
d. installation and structural

2. Where can you obtain information that may not be given in the general view plan of a building?

a. main view
b. detail view
c. plot plan
d. vertical view

3. In what plan can you find the height of the ceilings in a building to be constructed?

a. floor framing
b. roof framing
c. wall framing
d. floor

4. In what plan would you find the heating, plumbing and lighting fixtures indicated?

a. plot
b. foundation
c. framing
d. floor

5. Where would 6′ - ¼″ be indicated on a drawing specifying dimensions?

a. at the junction of extension and working lines
b. slightly above working lines
c. at each end of an extension line
d. slightly above or within a dimension line

6. What do break lines indicate?

a. that there is a change in the detail of an object
b. the location of certain structural parts
c. that an object continues without change in detail
d. the distance between two points in the plan

7. How would you order lumber that you intend to cut into several lengths?

EDITION 0 (NRI 011)

a. by linear foot

b. by board foot

c. by square foot

d. by the piece

8. When you want to set the head of a nail below the surface of the wood, what kind of nail would you use?

a. casing

b. finishing

c. box

d. common

9. Which of the following woods is nonresinous?

a. hemlock

b. mahogany

c. spruce

d. fir

10. In the preservative treatment of wood with creosote or zinc chloride, what method gets the most satisfactory results?

a. dipping

b. hot and cold

c. pressure

d. painting

11. When you hone a chisel, what happens to the stone if you move the chisel back and forth over the length of the stone?

a. the stone wears evenly

b. bevel is made flat with toe and heel

c. a better cutting edge results

d. ridges and grooves are worn in the stone

12. Which of the following is a supporting tool?

a. vise

b. wrench

c. automatic screwdriver

d. sawhorse

13. How many teeth to the inch should be on a hand saw for rough cutting?

a. 12 to 14

b. 10 to 12

c. 6 to 8

d. 6 to 10

14. For which of the following would you use a mortise chisel?

a. for chipping stone cornices

b. heavy work

c. to remove much material from large surfaces

d. lightweight window frames

15. When you sharpen a firmer chisel, what is the least angle at which you grind it?

a. 20°

b. 25°

c. 30°

d. 35°

16. What carpenter square does the work of a depth gauge and level?

a. combination

b. framing

c. try

d. miter

17. How far above the wood being cut should the cutting teeth of a table saw project?

a. 1/8"

b. 1/4"

c. 1/2"

d. 1"

18. If you had to cut internal and external curves on a piece of work, which of the following would you use?

a. band saw

b. rip saw

c. jig saw

d. overarm saw

19. What sander is normally used on edges of material?

a. disk

b. drum

c. belt

d. spindle

20. What chisel would you use to make bead and "V" cuts?

a. round point

b. square point

c. skew

d. spear point

21. What is the size range of the bits and chisels used with the hollow chisel mortiser?

a. ¼ to 1 inch

b. ½ to 1 inch

c. ¼ to ¾ inch

d. ¾ to 1 inch

22. About how many pounds can a rung of a good ladder sustain?

a. 150

b. 500

c. 550

d. 600

23. When you adjust the length of an extension ladder for your use, how much should the sections overlap?

a. 2 feet for 62 foot extension

b. 3 feet for 38 foot extension

c. 5 feet for 45 foot extension

d. 6 feet for over 45 foot extension

24. What is the minimum size of first grade manila or wire cable that you may select as supporting ropes of a suspended scaffold?

a. ½"

b. ¾"

c. 1"

d. 2"

25. How much greater a load should a scaffold be able to support than the load that you expect to put on it?

a. 5 times greater

b. 4 times greater

c. 3 times greater

d. 2 times greater